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No. 1. — (Letter No. 1.) *To* C. P. Patterson, *Superintendent Coast Survey, Washington, D. C., from* Alexander Agassiz, *on the Dredging Operations of the United States Coast Survey, Steamer "Blake," during parts of January and February,* 1878.

Since I joined the ship at Havana, during the last part of December, 1877, not only have our operations been greatly retarded by continued bad weather, but also by the unfortunate grounding of the "Blake" at Bahia Honda while in charge of a Spanish pilot. Nearly three weeks were lost before the ship could be floated and again in condition to resume work. Notwithstanding these delays, the following lines have been run thus far: —

1. One line from Havana to Sand Key in depths of from 320 fathoms to 951 fathoms.

2. A second line on the coast of Cuba from Havana to a short distance west of Bahia Honda, from 292 fathoms to 850 fathoms.

3. A short line of about 40 miles northerly from the Tortugas, from 111 fathoms to 37 fathoms, to examine the character of the Fauna of the Florida Bank to the westward of the mainland as far as the 100-fathom curve.

4. A line from the 100-fathom curve on the west side of the Florida Bank about 30 miles north of the Tortugas, across to the 100-fathom curve on the northeastern side of the Yucatan Bank, from 110 fathoms to 1,920 fathoms to 95 fathoms.

5. A line from 1,568 fathoms north of the Alacran Reef, from the deep basin extending from the northern slope of the Yucatan Bank toward Vera Cruz up to 84 fathoms on the northern edge of the Yucatan Bank.

6. A line from the 100-fathom curve on the north side of the Yucatan Bank to Alacran Reef, then in a southeast direction from there into 20 fathoms off the Joblos Islands diagonally across the Yucatan Bank.

7. A line in the trough of the Gulf Stream from north of Cape San Antonio to Sand Key, Florida, from 1,323 fathoms to 339 fathoms.

In all, about 1,100 miles of lines, taking the shortest distances from point to point.

The Fauna of the Yucatan Bank is identical with that of the Florida Bank, being characterized by the same species of Echinoderms, Mollusks, Crustaceans, Corals, and Fishes, so well known already from shallow water on the Florida side. While on the Yucatan Bank I had the chance of examining the great Alacran Reef, an excellent plan of which is given on one of the British Hydrographic maps of the Gulf of Mexico. It is one of the circular reefs resembling atols, and I was the more desir-

ous to get an idea of its mode of formation, because, according to Darwin's theory of coral reefs, such atols should not occur in areas of elevation like those in which the Florida reefs, the coast reefs of Cuba, the Bahamas and the Central American reefs are found. The examination of Alacran Reef showed it to be in full activity, the eastern slope being nearly perpendicular, rising in a comparatively very short distance from 20 fathoms to the surface. The eastern side forms a huge semicircle exposed to the full force of the northeast trades, and the surf breaks heavily against the great masses of Madrepora palmata which build up the narrow line of coral just awash or barely flush with the level of the sea. The greatest length of the reef is about fourteen miles; its width, eight miles. It forms a very regular elliptical ring, the eastern half of which rises boldly from 20 fathoms, while the western half consists of half-finished narrow islands. These islands are mere strips of sand formed by the breaking up of the exposed coral heads, which are gradually cemented together by the accumulation of the loose materials, sand, etc., held in suspension by the water, and constantly driven westward by the northeast trades. The space intervening between the two edges of the reef is from one to six fathoms in depth, filled in its shallower parts by huge masses of Astræa, of Gorgoniæ, of Maeandrina, of Madrepora palmata, which occasionally rise to the surface. The intervening spaces become choked by the sands formed by the decomposition of the eastern edge of the reef, under the unceasing action of the heavy surf. These heads are thus separated by lanes of sand, forming deep gullies in which the growth of the corals or Gorgoniæ has been arrested by the prevailing drift to the west. These heads are gradually but steadily approaching the western strip of islands, and will in time completely fill the whole space in the interior of the reef, or will leave only a narrow channel varying in depth between the outer broad bank to the east and the narrow islands to the west. The corals on the west side of the western islands, and also on the western slope of the reef, grow on a much more gentle slope, the 10-fathom curve being from an eighth to half a mile or even more distant from the shore of the islands. Other reefs are beginning to rise on the Yucatan Bank, near the 30 or 20 fathom curve. The whole structure of this reef shows its identity of formation with that of the main Florida Reef, and with that of the reefs on the northern coast of Cuba, where the line of distinct and powerful elevation can be still plainly traced by old coral slopes and by the ancient coral reefs in the hills surrounding Havana and extending to Matanzas. These hills attain a height of over 1,200 feet, and are entirely composed of species

of corals identical with those now found on the living reefs. Alacran Reef thus gives us an easy explanation of atols, apparently formed in areas of elevation, and I shall on another occasion further compare the structure of this interesting reef with that of the great Florida Reef, and of the Bahamas Bank, as I look upon it as a sort of epitome of the mode of formation of these extensive reefs. Taken in connection with its position on the Yucatan Bank, it will perhaps explain the mode of formation of the greater part of the Florida peninsula as connected with the bank lying to the westward of the mainland and to the northward of the Florida Reefs.

Along the Cuban coast the dredge brought up a large number of silicious sponges, as well as many interesting forms of Corallispongiæ. Here we found a species of Favosites, perhaps the most interesting coral ever dredged, and many of the corals and Gorgoniæ collected by Count Pourtalès on the rocky plateau to the south of the Florida reefs in from 200 to 300 fathoms. Although innumerable fragments of stems of Pentacrinus and portions of the arms frequently came up in the dredge, we were not fortunate enough to obtain a single entire specimen, but we obtained a young Holopus in excellent condition. While running our first line from Havana to Key West, we used the dredge exclusively, and brought up from the trough of the Gulf Stream in the deepest parts nothing but Globigerina ooze, apparently confirming Mr. Pourtalès's results, who, in 500 fathoms' dredging over the same kind of bottom, had also found nothing indicating an abundant fauna.

Subsequently, however, we used the trawl and a modification of the dredge over the same bottom, on the line from Cape San Antonio to Sand Key, and we were surprised to find an abundance of life at all depths, from 1,323 fathoms upwards, showing that the Globigerina ooze is, on the contrary, particularly rich in animal life, as Thomson and his associates in the "Challenger" also found it to be. Our hauls over this Globigerina ooze and coral ooze gave us Echinoderms, Hydroids, Polyps, Mollusks, Crustacea, Annelids, and Fishes; one of the most interesting hauls on this line was from 860 fathoms, bringing up an unusually large number of Lamellibranchiata and Gasteropoda of small size, but including many of exquisite beauty.

The results of the hauls on the line from the Tortugas to the eastern edge of the Yucatan Bank were perhaps the most interesting, and I had often occasion, while examining the contents of the trawl from our greatest depths to recognize old "Challenger" friends, — forms I had become acquainted with while examining the collection of the "Challenger" last winter in company with Sir Wyville Thomson.

It was on this line (from 968 fathoms) that we first obtained specimens of the eyeless Macrouran (Willemœsia), closely allied, if not identical, as were most of our deep-water species, with those brought up from great depths in the Atlantic by the "Challenger" expedition. From 1,920 fathoms on this line we brought up magnificent specimens of the brilliant scarlet Gnathophausiæ, and other gorgeously colored Macrourans allied to those referred by Thomson to Astacus. From a somewhat less depth we obtained a gigantic Isopod closely allied to Aega, measuring more than eleven inches in length and three in width. In the same trawl we obtained (and at greater depth also) several species of fishes similar to those secured from deep water by the "Challenger" belonging to the Macrouridæ and Ophidiidæ. One species was especially interesting, resembling a huge tadpole with a gigantic cartilaginous round head and without eyes. Some of the other species are undoubtedly identical with those mentioned by Günther in his preliminary report on some of the "Challenger" fishes. I am, however, unable to refer to it at present. Among them were a couple of species of a genus with elongated flattened heads, diminutive eyes, and furnished with gigantic filaments fully as long as the body, extending from the tips of the pectorals and from the lower caudal lobe; these filaments probably have the function of organs of touch. We also brought up from this line in deep water a number of silicious sponges, among them Poliopogon amadou W. T., Hyalonema toxeres W. T., fragments of Leporella, of which a number of specimens were found off the coast of Cuba, as well as fragments of an Euplectella allied to E. tuberea W. T., a large specimen of which had been previously dredged by us off Bahia Honda. In 1,568 fathoms we obtained a single fine specimen of Umbellaria in excellent condition. It came up in a trawl nearly choked with ooze, containing, among other things, several species of the remarkable deep-sea Holothurian family obtained by Thomson along the coast of Portugal. These Holothurians are large masses of jelly brilliantly striped longitudinally and transversely with deep crimson bands, the mouth placed on the lower side, which forms a kind of foot, as in Psolus and Cuvieria; others of the group were perfectly transparent.

On the edges of the Florida and Yucatan Banks, in shallower water, from 400 to 900 fathoms, we found the same species of Echinoderms already known from the explanations of Count Pourtalès in the U. S. C. S. S. Bibb. Among them were several species of pentagonal starfishes allied to the genera Archaster, Astrogonium, Hippasteria, and the like, as well as many good specimens of Coelopleurus, Saleniæ, Neolampas, and

other Echini of which former expeditions had only attained a few broken or single specimens. I recognized a number of the Bryozoa and Hydroids described by Smitt and Allman, in addition to several new forms.

The line (5) extending into deep water from the north of Alacran Reef did not give us anything which had not already been found in line four (4), extending from the Tortugas across to the Yucatan Bank.

On the eastern edge of the Yucatan Bank we obtained from deep water a new genus of Diadematidæ allied to Centrostephanus; the same has also been found by the "Challenger" off Madeira, if I am not mistaken. From shallower water we obtained a number of fine specimens of the extinct genus Conoclypus, of a brilliant lemon-color; with it came up a number of specimens of Rhizocrinus. The latter appear to be more abundant on the rocky bottom in from 300 to 400 fathoms along the edge of the Florida Reefs. On one occasion off Sand Key the dredge must have passed through a forest of them, judging at least from the number of stems and heads of all sizes which it contained.

On one occasion during a short calm, half-way between the Tortugas and the eastern edge of the Yucatan Bank, I had an excellent opportunity of seeing a number of Globigerinæ and Orbiculinæ alive. They were swarming near the surface, the nucleus of a brilliant vermilion, in company with a host of Diphyes, Pteropods, Heteropods, masses of gulfweed, and the accompanying countless larvæ of Crustacea, Mollusks, and Fishes, which inhabit this weed.

Of course, during the cruise, careful soundings were taken with Captain Sigsbee's modification of Sir William Thomson's sounding-machine, and bottom and surface temperatures with the Miller Casella thermometer were all carefully compared from time to time with a standard. No serial lines of temperature were taken, as they were either already on hand, or were to be taken later in the season by Captain Sigsbee in the course of his regular work after I had left the "Blake." We obtained again, as had been found in previous years, a uniform bottom temperature of 39½° Fahrenheit, below 600 to 700 fathoms. This uniform bottom temperature is undoubtedly connected with the depth to be found between the windward islands through which the cold waters of the Atlantic, from similar depths, force their way slowly northward, first into the Caribbean Sea, and then into the Gulf of Mexico, through the Straits of Yucatan. An additional series of observations over a careful line of soundings across these various inlets would be interesting, as affording, in connection with the line to be run by Captain Sigsbee across the Straits of Yucatan, means of comparison with the temperatures of the

Gulf of Mexico at similar depths. This is the more important because the hydrography of the gulf is now, as you well know, so far advanced that when the present season is finished, and the results are plotted, we shall have a hydrographic chart with accompanying temperature profiles in sufficient number to give an admirable account of the Physical Geography of the Gulf of Mexico.

I was very much struck, on first seeing the ooze of the deep water of the Straits of Florida between Havana and Florida Keys, with the immense number of dead Pteropod shells which it contained, in addition to the countless tests of Globigerinæ and Orbiculinæ. These shells belonged mainly to the genera Clio, Hyalæa, Triptera, Atlanta, Styliola, etc., all of which swarm on the surface, or a little below it, in all the parts of the Gulf of Mexico which we have thus far passed over. I could at once see how important a part these dead shells of Pteropods would play in the formation of the sedimentary matter accumulating at the bottom. Globigerinæ and Orbiculinæ form, as we know, the bulk of the ooze, but the remaining part of the mud is made up mainly of the dead shells of Pteropods in all stages of disintegration, from perfect shells, still filled with the decaying animals, to the most minute grains, in which we can just detect the presence of the Pteropod test. This composition of the ooze was the universal rule in all specimens of the bottom which I have had thus far time to examine. This plainly shows that Pteropods as well as Globigerinæ and Orbiculinæ, with other pelasgic animals swarming at the surface of the sea at great distances from the land, are an important factor in the composition of all the deep-sea deposits going on at the present day. Of course they must have played a similar part in the deposition of amorphous limestone formations in former geological periods. Whether this decomposition of the test becomes more rapid with increasing depth, as is the case in the deep-sea red clay of the "Challenger," I have not yet been able to ascertain, from the rapid examination of the samples of bottom thus far obtained. To show how far the dead Pteropod shells make up the Globigerina ooze, I took, from the contents of the trawl from 860 fathoms, equal portions of mud as it came up; one part was left and roughly measured, the other was first carefully sifted, the Pteropod shells and their fragments were then collected, and likewise measured, when their bulk was found to be somewhat more than half the bulk of the sifted mud from which they came. This mud was intensely cold, and it was a strange sensation to have your back and head burning under the scorching rays of the sun, while handling, with benumbed fingers, the ice-cold masses of mud of 39½° Fahrenheit, brought up by the dredge.

I need not speak to you of the successful working of Captain Sigsbee's water-cup, far superior in efficiency and accuracy to any cup thus far employed by the deep-sea explorations preceding us. His modification of Thomson's wire sounding-machine, which has now been in use for four seasons, has continued to work as successfully as formerly. Though an old story to you, to those who are not familiar with the practical working of deep-sea soundings as formerly carried on, a few figures enabling them to compare the old with the new methods may be interesting. In the "Challenger" the deep-sea soundings were made with a rope of eight tenths of an inch in circumference, nearly as large as the steel wire rope which we used in dredging, and having a breaking weight of 1,200 pounds. The time occupied in lowering the sounding-machine and its weights, often more than 300 pounds, was three to four times as great as in our case. We employed a steel wire (No. 20, American gauge), with breaking weight of 240 pounds, only weighted for the deepest soundings with a 50-pound shot. The time required to reel in with Captain Sigsbee's wire machine was always below one minute per 100 fathoms, sometimes not more than 20 seconds, while the time required to strike bottom averaged from 35 to 45 seconds per 100 fathoms in the deepest soundings up to 2,000 fathoms. The steel wire rope, of which I suggested the use in our dredgings, has worked admirably. In fact, I do not see how, with a vessel of the size of the "Blake" (of only 350 tons), we could have found room for the hemp rope necessary for our work. The wire rope we used was of galvanized steel with a hemp core; it measured one and one eighth inches in circumference, weighing one pound to the fathom, with a breaking strain of over 8,600 pounds, as tested by the Roebling & Sons' Company, the manufacturers. We took with us only two coils, each of 3,000 fathoms. One coil was on deck, wound to an iron reel and frame provided with a friction break for lowering the dredge or trawl, the whole space occupied by this length of rope on the reel being only five feet long, by four feet wide, and five feet high. In addition to the economy of space thus gained, we were enabled to dispense with sending down heavy weights to drag in front of the dredge at a distance from the frame, as was invariably done by the "Challenger," the weight of the steel rope in water rendering this unnecessary. Our greatest gain from the use of steel wire rope came from the rapidity with which we could lower and hoist the dredge. In fact, this was done as rapidly as is customary in lowering or hoisting skips on the slope of a mine. Our usual speed in lowering the dredge until it came within a few fathoms of the bottom was between two and a half and three minutes for

a hundred fathoms, when we lowered more carefully, and then payed out the slack very gradually, the dredge dragging on the bottom all the time. In bringing it up after the dredge was clear of the bottom, it was hoisted again at the same speed, and as far as I could perceive the specimens were none the worse for their rapid upward journey. This gave us a chance to make several hauls a day, and by not leaving the dredge or trawl to drag too long on the bottom, we obviated the great loss of time due to fouling, reversing, or any other accident out of sight. In the "Challenger" the best part of the day was generally consumed in making a haul at a depth of 1,500 fathoms. We experienced no inconvenience from the kinking of the rope, if kept well stretched, and not allowed to lie slack on the bottom.

We have modified somewhat the dredges generally used. While using the dredges, as formerly made, with a frame having a bevelled edge, especially on muddy bottom, we experienced great annoyance at first from the amount of mud brought up by it. When the dredge is used in soft ooze, it evidently sinks deeply in it and fills at once, and, the viscid mud not washing out easily, it is even difficult to sift it on deck. To obviate this defect, we stopped a piece of two-and-a-half-inch rope below the dredge frame to raise the lips and prevent it from cutting into the mud. This worked admirably, and after that our dredges always came up bringing less mud and a larger supply of specimens. We are now making a dredge with a flat frame for use on our next trip. We are also attempting a modification of the beam-trawl; as at present used, there is constant danger, in lowering it to great depths, below 1,000 fathoms, that it will not fall properly, no matter how well balanced it may be, owing to currents or the drift of the vessel. We have therefore devised a new trawl bearing to the old beam-trawl the same relation which the ordinary dredge bears to the old oyster-dredge, and we hope thus to have a trawl which will not fail to do its duty on whatever side it may happen to fall. The tangles we found invaluable, especially on rocky bottoms, where there is always danger of carrying away either a dredge or a trawl.

I made no attempts to use the tow-net at great depths to ascertain the presence of Foraminifera, Radiolaria, or other pelasgic animals at a considerable distance from the surface. All naturalists familiar with the use of the dip-net, the tow-net, or its modification first employed below the surface by Baur, know that the pelasgic animals are driven from the immediate surface, by winds and rain, or by some other cause, into moderate depth, where they may always be procured, while at greater

depths they fail to find them. Such, at least, has been the experience of Johannes Müller, Claparède, and a host of others who have followed their methods of fishing either at the surface or a little below it. The specimens brought up by the "Challenger" from intermediate depths are inconclusive, since the nets used were the ordinary tow-nets, which were sent down open, kept open while towing, and remained open while coming up. It is perfectly true that by differentiation of the contents of the several nets at one locality some approximate results might be obtained, if the work were carried on for a long period, but an occasional haul taken by itself means nothing. For this reason, our time having been already so far curtailed, it seemed useless to devote any portion of the pleasant weather suitable for dredging to carry on work which at best would only accumulate very indifferent evidence. We have, however, attempted to devise a tow-net which will go down closed to any depth required, will then open and tow while the ship is in motion, and close again within a reasonable distance as it comes up. But thus far the experiment has not succeeded.

The number of casts made with dredge and trawl are over fifty, from 300 fathoms to 1,920 fathoms; of these forty-three were successful hauls. In making them we have thus far only lost 200 fathoms of steel rope.

We leave to-morrow to run a line of dredging from the Tortugas to the mouth of the Mississippi River.

I am fortunate in having on this expedition, as on former collecting excursions, the valuable and faithful assistance of Mr. Garman. Beyond this, whatever share of success has attended this winter's work is due to the untiring energy of Captain Sigsbee. The interest taken not only by him, but by all the officers and men of the "Blake," has not flagged for an instant, day or night, as the amount of work accomplished during the comparatively short time of good weather amply testifies.

Alexander Agassiz.

Key West, Feb. 27, 1878.

No. 2. — *On the Presence of* Demodex folliculorum *in the Skin of the Ox.* *By* Walter Faxon.

Last January my attention was called to the diseased condition of cowhides received from Illinois and Minnesota by Webster & Co., of High Street, Boston. In the parts about the neck and shoulders, especially, the skins presented numerous slight swellings, which under pressure emitted a quantity of soft whitish matter. After being tanned and split, the leather appeared disfigured with pits from one to six millimetres in width, which in many cases penetrated nearly through the thickness of the leather (Fig. 1). Some of these cavities were filled with a yellowish stuff easily removed by the point of a knife. In many of the samples eight or ten pits occurred within the area of one square inch. On placing a drop of the matter taken from the pimples of the hides under the microscope, it proved to be a fatty substance containing multitudes of *Demodex folliculorum.* Sections of the skin showed the cavities to be diseased and enlarged hair-follicles (Figs. 2, 3, 4). All the infested pieces which I was able to obtain had been subjected to the lime-soak and other processes prior to tanning. I was therefore unable to make out the structure of the parasite as minutely as I might, had I fresh specimens at my command.

Description. The body (Fig. 6) is of a long oval, flattened form, narrowing abruptly at the anterior end, but tapering gradually to the posterior extremity, which is blunt. There is no very marked division between the cephalo-thorax and the abdomen. Under a high magnifying power the abdomen is seen to be lightly annulated, the annulations being strongest toward the hind end of the body.

On each side of the mouth is a large two- or three-jointed palpus, of which the proximal segment makes the bulk. The distal segment bears two or three minute hooks. Toward the distal end of the proximal segment of each palpus is a minute oval body. This is probably the structure called an *eye* by Erasmus Wilson.* I take it to be a thickening of the integument, probably for the attachment of muscles. At the base of the palpi are some exceedingly minute structures (Fig. 7), the nature of which I could not determine. Above and within the palpi lie the mandibles, two styliform organs which rarely project beyond the median plate (*epistoma*), which seems to lie above all the other mouth-

* Phil. Trans., 1844, Pt. I, p. 309.

pieces, and whose convex anterior edge commonly forms the front boundary of the head between the palpi.

Behind the palpi are four pairs of short legs. Each consists of three movable segments, the proximal segment articulating with an immovable basal plate (haunch). The first pair of legs is directed forward at an angle of about forty-five degrees with the long axis of the body. The remaining pairs are nearly transverse, the hindmost inclined a little backward. The basal plates are very large, and each one almost meets its fellow in the middle line of the breast, so that there seems to be a double line running the length of the body in the median line below. These plates are quadrilateral, their outer margins oblique, their hinder and outer angles produced.* The first movable segment is triangular, the apex of the triangle pointing backward. The second and third segments are successively smaller, and the latter is armed with two claws.†

I discovered no anal nor genital aperture, nor could I detect any internal structure beyond the myriads of fat globules in the abdomen.

Length, about one fifth of a millimetre.

In some of the infested follicles bodies were found which are probably the eggs of the *Demodex*. They are oval or reniform.‡

History. Our parasite was first discovered by Henle § in the hair-

---

* The transverse "double-line stripes" of Simon, which I regard as formed by the posterior and anterior margins of the basal plates of two consecutive appendages, are considered by Mégnin (and in this he agrees with Küchenmeister) to be epimera, to the ends of which the legs are articulated. He says: "C'est par suite d'insuffisance de connaissances en anatomie comparée des Acariens que MM. Cornevin et Pennetier comptent quatre articles aux pattes des Demodicidés : ils comptent à tort comme un premier article l'espace compris entre deux épimères qui se suivent." But I see in preparations of *Hypopus* the same arrangement of parts, the haunches of either side almost meeting in the middle line of the breast so as to produce the appearance of breastbone and ribs. This is well shown in Dujardin's figures in Annales des Sciences Naturelles, 3d series, Vol. XII. Pl. 11. Compare also the "Hüftplatten" of *Labidophorus* Kramer, Archiv für Naturgeschichte, 1877, Pl. XVI. The question whether the basal pieces are really the proximal segments of the limbs soldered to the sternum (a view long ago held by Miescher) or whether they are true sternal elements, is a secondary one.

† There is much difference of opinion with reference to the number of claws on each leg. Simon thought there were three. According to Miescher there are four on the two anterior pairs, five on the posterior. Wilson counts seven or eight. The error is due to little projections from the claws, seen in optical section.

‡ According to Wedl and Mégnin *Demodex* is viviparous, and the bodies commonly supposed to be eggs are the earliest stages of the larvæ and are capable of motion. In some of those which I saw there seemed to be a distinct transparent shell within which the yolk had shrunk so as to occupy but a part of the cavity.

§ Unless anticipated by Berger. At a meeting of the Académie des Sciences of Paris, May 19, 1845, Berger opened two sealed packages which had been laid before the society on the 2d of November, 1841, and the 14th of February, 1842, and which contained an

follicles of the external auditory canal of dead human subjects, and the first notice of it appeared in the "Oeffenlicher Beobachter" of Zürich in December, 1841, in a report of a meeting of the Naturalists' Society of that place.* Henle completely misunderstood the nature of the parasite, which he was inclined to place in the neighborhood of *Polystoma*, mistaking the legs for the suckers of the Trematode, the head for the tail. He gave it no name.

About the same time, the mite was observed independently of Henle by Gustav Simon, a physician of Berlin, who published a very careful description of it, together with figures, in Müller's Archiv for 1842.† It was in the course of his studies of certain diseases of the human skin (*Acne, Comedo*) that Simon discovered the parasite in both diseased and healthy hair-follicles in the nose of living and dead subjects. Erichson, who was consulted by Simon with reference to the zoölogical position of the newly discovered animal, placed it among the mites, and named it *Acarus folliculorum*. Simon included in his description and figures the young form of the animal, which has but three pairs of legs, and also what he thought to be the egg-shell. In the following year, 1843, Owen,‡ without making any new observations, fixed the position of the animal more precisely, making it the type of a new genus, *Demodex*, and during the same year Miescher § published a description of it under the name *Platypus macrogaster.* ||

Erasmus Wilson,¶ also in 1843, made extensive studies upon the structure and development of this animal, and his results were published in the Philosophical Transactions of the Royal Society for 1844. He found it in the hair-follicles and sebaceous glands of healthy as well as of torpid skins, commonly in the face, but also in the back, breast, and abdomen.

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account of our parasite found in the cerumen of the ear. He put it among the Tardigrades, and no name was given it. Comptes Rendus, XX. p. 1506, 1845. Froriep's Neue Notizen, XXXV. p. 58, 1845.)

* *Teste* Miescher.

† "Ueber eine in den kranken und normalen Haarsäcken des Menschen lebende Milbe.' Arch. f. Anat. Physiol. u. Wissensch. Med. 1842, pp. 218–237, Pl. XI.

‡ Lectures on the Comparative Anatomy and Physiology of the Invertebrate Animals, p. 252, 1843.

§ Bericht über die Verhandlungen der naturforschenden Gesellschaft in Basel, V. pp. 191–198, 1843. (Communicated Mar. 2, 1842.)

|| I have not been able to see Erdl's paper on *Demodex* in the Bulletin of the Academy of Munich, 1843.

¶ "Researches into the Structure and Development of a newly discovered Parasitic Animalcule of the Human Skin, — the *Entozoon folliculorum*." Philosph. Trans. Royal Soc.

One finds it impossible to place any confidence in Wilson's account of the excessive complication of structure of the parasite. He describes the head as furnished with a pair of eyes, palpi, labrum (?), eight pairs of tentacles, and four to ten pairs of maxillæ! He is disposed to remove the creature altogether from the Arachnida and put it in close relation with the Annelides or the lower Crustacea. Waiving the question of its exact systematic position, he gives it a provisional name, *Entozoon folliculorum.** The first notice of the presence of *Demodex* in other animals than man was a communication read by Mr. Tulk before the Microscopical Society of London, December 20, 1843.† He obtained specimens from Mr. Topping, a preparer of microscopic objects, who found them in the contents of pustules on a mangy dog. The parasites were very abundant, sometimes thirty or forty in a single drop of pus. The dog was spoken of as "a perfect mass of disease."

In 1844 the animal received a name for the fifth time, when Gervais, translating a part of Dr. Simon's paper for the "Histoire Naturelle des Aptères" proposed the name *Simonea folliculorum.*‡

The next observer to turn his attention to this subject was Gruby,§ who found the *Demodex* in men and dogs, causing in the latter a serious mangy affection of the skin. He noticed that the parasites spread in a circle from follicle to follicle, and believed that the human and canine forms were the same species, and capable of transmission from one host to the other.

In 1845 Dr. Gros announced the discovery of *Demodex* in the snout of the dog, fox, horse, ox, etc.‖

At a meeting of the "Freunde der Naturwissenschaften" in Vienna, March 26, 1847, Dr. Carl Wedl presented a paper on the anatomy and development of *Demodex.*¶

Küchenmeister, in his work on the parasites of the human body, 1855,

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London, 1844, Pt. I. pp. 305-319, Pl. XV.-XVII. (Read Mar. 30, 1843. Abstract in Ann. and Mag. Nat. Hist. XII. p. 222, 1843, and in Proc. Royal Soc. V. p. 495, 1843-44.)

* In his "Diseases of the Skin," 2d ed., 1847, Wilson gives the parasite a new generic name, *Steatozoon.*

† An abstract of this communication is given in "The Annals and Magazine of Natural History," XIII. p. 75, 1844.

‡ Hist. Nat des Insectes, Aptères, III. pp. 153, 282, 1844.

§ "Recherches sur les animalcules parasites des follicules sébacés et des follicules des poils de la peau de l'homme et du chien." Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences, XX. pp. 569-572, 1845.

‖ Bulletin de la Société Impériale des Naturalistes de Moscou, XVIII. p. 415, 1845.

¶ "Ueber die Haarsackmilbe (*Acarus folliculorum*)." Haidinger's "Berichte." Bd. II. pp. 272-277, 1847.

gives an account of the structure and mode of life of the parasite of the hair-follicles.*

In 1859 appeared a valuable paper on *Demodex* by Leydig,† containing descriptions of the parasite found on man, the cat, the dog, and a bat from Surinam (*Phyllostoma*). On the latter hundreds of specimens were found in a pustule on the belly. He considers the forms from the various hosts as so many species.

The most important contribution to the history of *Demodex* since 1860 is a memoir by Mégnin.‡ In this memoir are described three varieties from man, the cat, and the dog.

In the above-mentioned papers *Demodex* has figured as a parasite of man, the cat, the dog, the fox, the bat, the ox, and the horse. It has also been reported from the Meibomian glands of the sheep.§

While in the human skin it is seldom found except in the face and is comparatively innocent, in the dog it may become widely spread over the body, and be the cause of a serious disease accompanied by a loss of the hair in the infected parts.

Although noticed in the ox by Gros, as long ago as 1845,‖ it has never been known, as far as I can learn, to induce any serious dermal disorder in that animal. Gros simply mentions it as found in the muffle. Its presence in such numbers as to damage the leather made of the infested skins must from its economic bearings awaken a fresh interest in this peculiar Arachnid. All the samples which I received had been soaked in lime in order to remove the hair, so that I cannot say whether the presence of the parasite causes the hair to fall off as happens with the dog; but at all events no crusts were formed upon the skin as in the mange. It is probable that the parasites would not have got such a hold upon the cattle unless their skins had become torpid by ill keeping.

It may be useful to quote here the treatment recommended by Simonds for dogs afflicted with these parasites, as it will apply equally well to cattle: —

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* "Die in und an dem Körper des lebenden Menschen vorkommenden Parasiten," 1855. English translation by Edwin Lankester, Vol. II. pp. 15–19, Pl. VIII. Figs. 14–16, 1857.

† "Ueber Haarsackmilben und Kratzmilben." Arch. f. Naturgeschichte, 1859, I. pp. 338–347, Pl. XIII. Figs. 4–10.

‡ "Mémoire sur le Demodex folliculorum, Owen." Journal de l'Anatomie et de la Physiologie (Robin et Pouchet), 1877, pp. 97–122, Pl. IX.

§ Küchenmeister, *op. cit.* (Eng. trans.), II. p. 17. Mégnin, *op. cit.*, p. 105.

‖ The record of this has been overlooked by most of the recent writers on the subject, e. g. Simonds and Mégnin.

"The destruction of the parasite is effected with great difficulty, arising chiefly from the circumstance of its being enabled so easily to make its way to the extreme ends of the hair-follicles and sebaceous glands. Success in destroying the Acari depends very much more on the manner in which medicinal agents are used than on the agents themselves. The most potent destroyers of their life may prove perfectly inert unless properly applied. Nothing short of a thorough rubbing in of whatever be used will suffice ; and not only so, but it is necessary for the agent to be applied again and again. An ointment made with half a pound of lard, two ounces of tar, and four ounces of sulphur should be well rubbed in before the fire or in the sun, to assist its penetration into the follicles of the skin. The unguent should also be allowed to remain on the skin for two or three days, and more friction applied daily. When washed off, some carbonate of potash should be used with soap and water, so as to thoroughly cleanse the animal. The skin should then be dried, and recourse had again to the unguent. This treatment must be repeated for at least three or four times.

"Beyond topical applications none are absolutely required, as success depends exclusively upon the destruction of the Acari and their ova. It should, however, be borne in mind that many of the parasites may survive, and yet no evidence of their existence be observed perhaps for several weeks. For this reason the treatment should be repeated at certain short intervals, even in those cases where the dog appears to have recovered." *

The specimens from different kinds of mammals differ but little in their appearance from each other, although Leydig considers them to be distinct species. In favor of this view the bulk of the evidence goes to show that they will not thrive when transferred to a host of a different kind.

The form we have had before us closely resembles that from the dog, but its body is shorter and wider. One would be rash to consider this a constant character, as it may be due to contraction after death.

CAMBRIDGE, April, 1878.

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* "Observations on Parasites and Parasitic Diseases as affecting Domesticated Animals." By James Beart Simonds. Journ. Royal Agricultural Soc. of England, 2d series, Vol. I. Pt. I. p. 72, 1865.

EXPLANATION OF THE PLATE.

FIG. 1. Inner surface of split leather showing the cavities formed by the enlarged hair-follicles. Six or seven of these cavities are filled with the sebaceous secretion. (Natural size.)

FIG. 2. Cross-section of a piece of the untanned skin from which the hair has been removed, showing one of the diseased follicles filled with fat. (Natural size.)

FIG. 3. Cross-section of the same. The sebaceous matter has been removed from the follicle. (Natural size.)

FIG. 4. A similar section magnified, showing one of the infested follicles together with four in the normal state. The light-colored bodies near the surface of the skin are sebaceous glands.

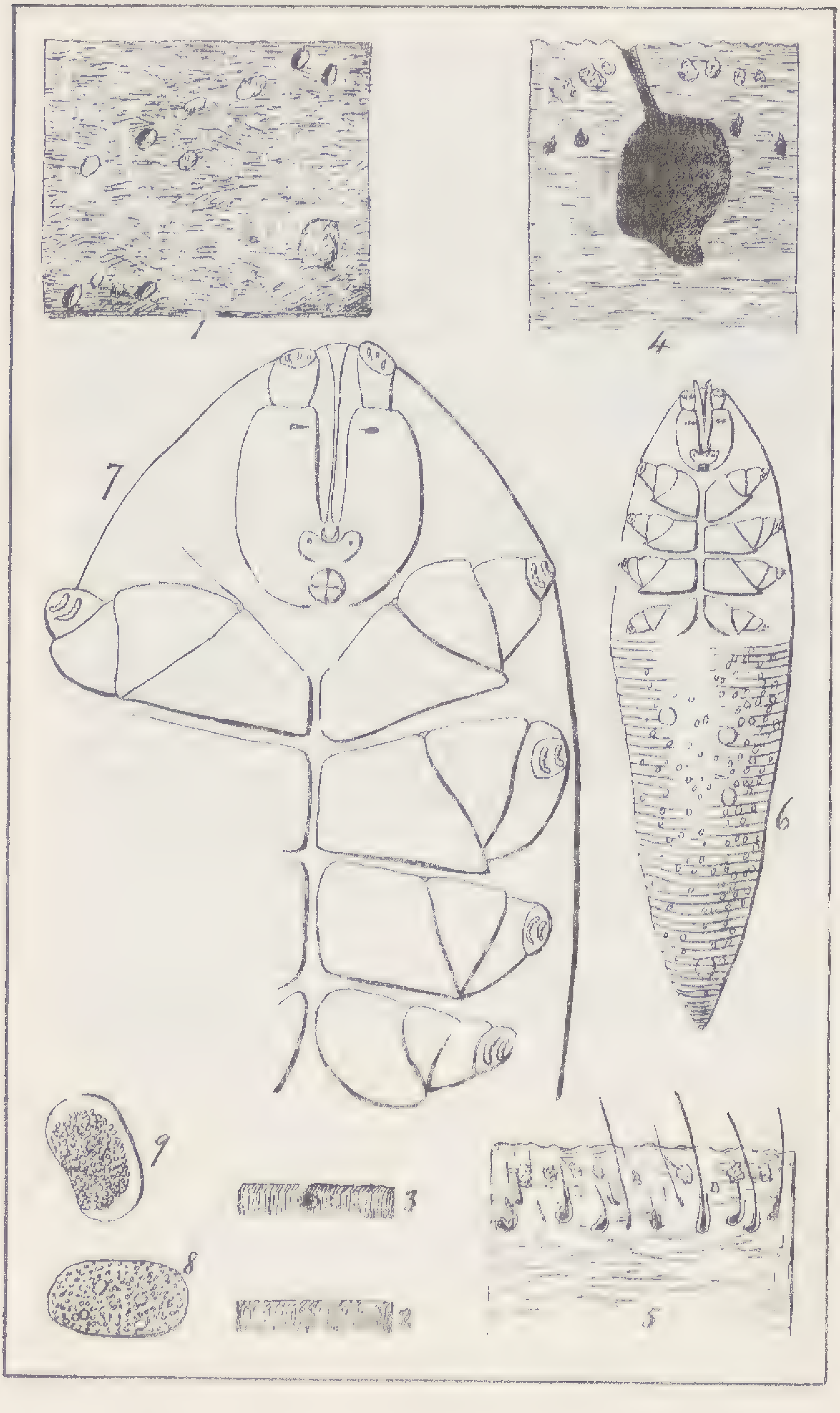
FIG. 5. Magnified section of a healthy skin from which the hair has not been removed.

FIG. 6. *Demodex folliculorum* from one of the infested hair-follicles, highly magnified (Hartnack obj. 9, oc. 4). The annuli of the abdomen are too strongly marked.

FIG. 7. Anterior part of the same, much enlarged.

FIG. 8. Egg of *Demodex?*

FIG. 9. The same, in which the yolk has shrunk away from the shell.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No. 3. — *The Richmond Boulder Trains, by* E. R. Benton.

INTRODUCTION.

The following is a list of the principal publications which relate to the Richmond Boulder Trains: —

Dr. S. Reid, "Berkshire Farmer," Lenox, Mass. 1842.

Edward Hitchcock, LL. D., Amer. Jour. of Science and Art. October, 1845. Page 258. Read before the Amer. Ass. of Geologists and Naturalists, at Washington, D. C., May, 1844.

Dr. Reid read a paper before the above Association, May, 1845.

Professors H. D. and W. B. Rogers, Boston Jour. Nat. Hist. June, 1846. Page 310. Read before the Boston Soc. Nat. Hist., December 3, 1845.

Sir Charles Lyell read a paper before the Royal Institution of Great Britain, April 27, 1855.

Sir Charles Lyell, "Antiquity of Man." Second Am. Ed. 1871. Page 355.

John B. Perry, Proc. Amer. Ass. for Advancement of Science, at the meeting held August, 1870. Page 167. Also Proc. Boston Soc. Nat. Hist. 1872. Page 110.

Dr. Reid, "Berkshire County Eagle." Pittsfield, Mass. January and February, 1876.

To Dr. S. Reid, formerly of Richmond, seems to belong the credit of first discovering, and bringing to the notice of geologists, the existence of trains of boulders in that region. One very distinct train, passing half a mile to the north of the Congregational meeting-house in Richmond, and composed of entirely different material from that of the bed-rock beneath, he traced to its source, three miles to the northwest, upon the crest of a ridge in Canaan, N. Y. He also traced it in the opposite direction eight or nine miles, across the Richmond Valley, the Lenox Range, and the Lenox Valley into the town of Lee, and he believed that its entire length was not less than twenty miles. Dr. Reid also described another train as starting from the same ridge half a mile south of the first, and running parallel to it for a distance of eight miles. He seems, however, to have attempted no explanation of the phenomena which he described.

Dr. Edward Hitchcock, in the American Journal of Science and Art, gave a restatement of Dr. Reid's observations, with some considerable additions thereto, and a sketch map exhibiting an outline of the topog-

raphy of the region and the author's idea of the direction and limits of two trains. He noticed the angular shape of the blocks, recognizing the consequent distinction between them and the rounded boulders buried in the drift beneath, and considered that, from their position on the surface of the drift, they must have been deposited later than that formation. He rejected both the view which attributed their distribution to currents of water, and that which attributed it to icebergs, and came to the final conclusion that the difficulties besetting every hypothesis of their origin were so great, that no satisfactory explanation could be given.

It was in 1846, the year following that of the publication of Dr. Hitchcock's paper, that Professors H. D. and W. B. Rogers set forth their views in regard to the origin of these boulder trains. The agency to which they were disposed to attribute the phenomena was the "paroxysmal or sudden and violent disturbance of the slightly flexible crust of the earth, causing, in the period of the northern drift, a partial elevation and displacement of the bed of the great frozen sea, which occupies the arctic latitudes, and sending its waters with all their ice in a sudden inundation over all the northern lands of the two continents." The Rogers brothers published at the same time a sketch map of the region, which does not differ essentially from that published by Dr. Hitchcock.

Sir Charles Lyell, in the "Antiquity of Man," describes two trains composed of "green chloritic rock," which are identical with the two mentioned by previous writers. He further states that there are five other parallel trains composed of limestone blocks, and originating in the Richmond Range, which lies to the east of the ridge in Canaan, and which he supposes to be made up of limestone. These seven supposed trains he exhibits upon a diagram, and represents the chloritic trains as crossing the Richmond and Lenox Ranges through gaps between the several peaks of those ranges. He expresses the belief that, at the time of the drift period, the highest points of the Canaan, Richmond, and Lenox Ranges formed chains of islands in an ocean, and that the gaps in the Richmond and Lenox Ranges were straits through which floated icebergs bearing the chloritic blocks from the exposed parts of the Canaan Range, and dropping them to their present positions.

Rev. J. B. Perry, in both of his accounts of these boulders, speaks of seven trains, two of chloritic slate, and five of limestone. The trains originate, according to Mr. Perry, partly upon a range of hills in Canaan, N. Y., but more especially upon the Richmond and Lenox Ranges, where the five limestone trains can be traced to their exact sources upon

isolated peaks of those ranges. He divides the boulders which rest upon the surface of the drift into two classes, according as they are rounded or angular, those which make up the trains being rounded, while the angular are distributed without definite arrangement. He considers that the trains owe their formation to the movement of the general ice-mass, which rested upon the region during the glacial period, the boulders which are found in trains, and which he believes to be rounded, having been torn from prominent peaks and forced along under the ice-sheet, while the scattered and angular ones were transported to their present position much later, when the ice-mass had become so reduced in thickness that the peaks in question projected above the surface, so that masses of rock could become lodged *upon* the ice, as well as be dragged beneath it.

Since boulders arranged in distinct trains are somewhat exceptional, it seems desirable that all the facts immediately connected with such boulders should be made known as fully and accurately as possible. With this end in view, a survey of the trains and other glacial phenomena, together with the topographical and geological features of the region was made by the writer, and the results of that survey have been indicated, so far as possible, upon the larger map which accompanies this paper.

The account of the boulder trains themselves will be preceded by descriptions of: 1. The Geography and Topography. 2. The Bed-Rocks of the Region. 3. Glacial Markings upon the Bed-Rocks. 4. Superficial Deposits underlying the Trains.

I am indebted to the courtesy of Professor H. F. Walling for the skeleton map of Richmond and surrounding towns, which I was enabled by his aid to prepare before visiting the field of study. I take this opportunity to present to Mr. M. E. Wadsworth also my thanks for his kind assistance in determining some of the rocks of the region, and especially for his study of the thin sections which were made.

To Professor N. S. Shaler and Professor J. D. Whitney, I wish to express my sincere gratitude, since I feel under great obligations to them, not only for timely suggestions with regard to the preparation of this paper, but for the many favors and the valuable instruction and counsel which I have received from them in years past.

1. GEOGRAPHY AND TOPOGRAPHY.

The area of territory studied in connection with the Richmond Boulder Trains is in the form of a belt extending about N. W. and S. E., and having as a centre the centre of the town of Richmond, Berkshire Co., Mass.; it has a length of nearly nine miles, with a breadth of three and a half, making an area of about thirty square miles. (See Map of Boulder Trains, and Note A, page 39.) A considerable part of the area to the west of the centre lies in the State of New York. Three parallel ranges of hills, all having a N. N. E. and S. S. W. trend, are included within the region studied.

CANAAN AND LEBANON RANGE.

The most westerly, or Canaan and Lebanon Range, is a simple ridge lying in the towns of Canaan and Lebanon, Columbia Co., New York. Towards the west its flanks slope quite gently to the adjoining valley, while at the foot of its steep northern terminus lies the village of New Lebanon in a broad valley, which is drained towards the Hudson River by the Wyomanock Creek. Fry's Hill, its highest point, is situated about midway of the length of the range, and is a prominent mass of rock rising about 200 feet above the general level of the crest of the ridge, and 620 feet above the Richmond station on the Boston and Albany Railroad.* For half a mile south of Fry's Hill the ridge is quite sharp, being very steep on the eastern side, and presenting, along its crest, an alternation of knolls and slight depressions. To the north of Fry's Hill the ridge, though still very precipitous on the eastern side, becomes somewhat broader, and ends, 1¼ miles N. N. E. of Fry's Hill, in a rocky prominence 525 feet high, called Douglas Knob.

East of the Canaan and Lebanon Range lies the Shaker Valley, the greater part of which is drained towards the north by a branch of Wyomanock Creek; Whiting's Pond, however, lying at the south end of the valley, receives a small portion of the drainage, and has an outlet towards the southwest. The divide between the two systems of drainage is on a level with the Richmond station, and is but eight to ten feet higher than Whiting's Pond, while the north end of the valley, near New Lebanon, is 360 feet below the Richmond station.

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* The level of the Richmond station on the B. & A. R. R., which is 1,050 feet above the sea, is taken as the plane of reference, the contours of that level being marked 0 on both the accompanying maps.

RICHMOND RANGE.

East of the Shaker Valley the Richmond Range rises very abruptly, its highest point being Perry's Peak, situated two miles E. S. E. from Fry's Hill, and having a height of 1,030 feet. Three fourths of a mile south of Perry's Peak the range divides into two nearly parallel ridges extending a little to the west of south, with an elevation of about 550 feet; and again the more westerly of the two ridges sends off four spurs towards the Shaker Valley, the most northerly of which is called Flat Rock; the next towards the south, Merriman's Mount; the next, Dupey's Mount, the most southerly being without a name. The Haskell Valley, included between the West Branch, and the East Branch of this range, has an elevation of about 300 feet.

On the east side, the Richmond Range has a comparatively easy slope towards the broad Richmond Valley, the drainage of which is, in the main, towards the south; the drainage of about one fifth of the area is towards the north into Richmond Pond, the divide between the two systems of drainage being 100 feet above the Richmond station.

LENOX RANGE.

East of the Richmond Valley rises the Lenox Range, its culminating point, Lenox Mountain, being situated about four miles S. 60° E. from Perry's Peak, and having a height of 1,065 feet. In the vicinity of Lenox Mountain the range is simple, but it branches, one mile to the south of that point, into two parallel chains of hills, which extend in a nearly S. W. direction, the hills of the more westerly branch having an average height of 600 feet, but diminishing in altitude towards the south. The Main Branch, which lies about three fourths of a mile east of the West Branch, is a sharp ridge, with an average height of about 700 feet; the height of the crest diminishes gradually towards the south, till, at a point situated three miles S. S. W. from the summit of Lenox Mountain, it is only 375 feet; from this point southward, the height rises in the next mile to 700 feet. The Cook Valley, lying between the Western and Main Branches, has an average height of about 400 feet. To the east of the Main Branch is a short parallel ridge, having a height of 675 feet, and called Prospect Hill, the valley between it and the Main Branch having a height of about 400 feet.

Towards the east, the Lenox Range slopes precipitously to the extensive Lenox and Stockbridge Valley, the height of that valley being, at Lake Mahkeenac, about 150 feet lower than the Richmond station.

2. BED-ROCKS OF THE REGION.

CANAAN AND LEBANON RANGE AND SHAKER VALLEY.

Along the western slope of the Canaan and Lebanon Range, the exposures of bed-rock consist of fine-grained mica schist, containing, in some localities, layers of white quartz from one fourth of an inch to one inch in thickness.

Upon the knob called Fry's Hill, on the crest of the Canaan and Lebanon Range, are exposures of fine-grained, foliaceous rock, very tough, and of a green color. It is a chloritic, probably metamorphic rock, and closely resembles that of which the Richmond Boulder Trains are composed. This rock is very limited in extent, being found, with one exception, only upon Fry's Hill, and in that locality not extending more than 150 feet below the summit. Its lack of stratification, its peculiar structure and limited extent seem to indicate that it may have been originally an igneous rock, but no direct junction of it with other rocks was found. In order to more fully determine its nature, thin sections were studied by Mr. Wadsworth, who considers it to be a chloritic schist.*

Just west of the summit of Douglas Knob, one and one fourth miles N. N. E. from Fry's Hill, the bed-rock is similar to that of the latter locality, except that it shows signs of stratification, and contains rounded grains of quartz, so that it is, in all probability, a metamorphosed, argillaceous sandstone. On the same range, a summit half a mile S. S. W. from Fry's Hill is made up of rock which closely resembles that just described as occurring at Douglas Knob.

Along the eastern slope of the Canaan and Lebanon Range the bed-rock is a friable and micaceous argillite, the exposures near the crest of the range being greenish gray, while those near the base are dark gray or nearly black.

Through the bottom of the Shaker Valley extends a broad belt of well-stratified highly crystalline limestone, containing no traces of fossils. This rock is mottled gray and white upon the fresh surface, but white when weathered.

RICHMOND RANGE AND RICHMOND VALLEY.

Upon the western slope of the Richmond Range, the rock is a fine-grained mica schist, in many places approaching argillite. Near the

* A more detailed account of the results of Mr. Wadsworth's microscopic analysis of this and other rocks of the region is contained in note B, page 39.

bottom of the slope, in the Shaker Valley, the mica schist contains a band of limestone, made up of two adjacent layers of different varieties of that rock. The upper layer is composed of thin-flaggy, crystalline limestone, of a gray color, without traces of fossils, and about seventy feet in thickness. The lower is composed of compact, crystalline limestone, without stratification, gray upon the fresh surface, and weathering buff. It is interlaced on the weathered surface with a network of fine fissures, and has a thickness of about thirty feet.

On the western slope of the spur called Merriman's Mount, near its summit, is an exposure of rock like that on Fry's Hill, and in the deep ravine between Merriman's Mount and Flat Rock, are exposures of rock which is very similar to that just mentioned, except that it is more schistose. On the western slope of Dupey's Mount, near its summit, is an exposure of rock resembling very closely that found upon Douglas Knob.

The eastern slope of the Richmond Range is composed of fine-grained, friable, argillaceous mica schist, usually containing layers of white quartz from one eighth of an inch to one inch in thickness. These layers are separated by irregular intervals, and are always more or less contorted.

The bottom of the Richmond Valley is occupied by a broad belt of limestone averaging two miles in width. This limestone is stratified, though not in all cases distinctly, is fine to coarse grained, highly crystalline, and without traces of fossils. The color varies from gray to white.

LENOX RANGE AND LENOX AND STOCKBRIDGE VALLEY.

Upon all parts of the Lenox Range, within the region studied, the bed-rock consists of ferruginous mica schist, bearing layers of quartz in even greater abundance than either the Canaan and Lebanon or the Richmond Range.

The Lenox and Stockbridge Valley, lying to the eastward of the Lenox Range, is occupied by limestone, which very closely resembles that of the Richmond Valley.

Some further remarks on the stratigraphical geology may be found in Note C, page 40.

3. GLACIAL MARKINGS UPON THE BED-ROCKS.

The greater part of the exposures of bed-rock on the upper parts of the three ranges exhibits the smooth surfaces with parallel grooves upon them, and the dome-shaped areas similarly marked, which are so characteristic of glacial action. The Canaan and Lebanon Range is thickly wooded, and has but few of these exposures, namely, — at Douglas Knob, Fry's Hill, and notably upon a summit situated half a mile S. S. W. from Fry's Hill. Upon Perry's Peak and along the crests of the two southerly branches of the Richmond Range, are many considerable areas showing the markings in question. The Lenox Range, for a distance of five and a half miles along its crest, has a continuous succession of dome-shaped areas, many of them worn so smooth as to be slippery, and generally distinctly furrowed.

The following table gives the direction of the striæ in various localities, the same facts being indicated on the map by short, parallel dotted lines.

Table showing Direction of Striæ.

(1.) $\frac{1}{4}$ m. S. S. W. of summit of Fry's Hill	S. 50° to 55° E.
(2.) $\frac{1}{2}$ m. " " "	S. 53° E.
(3.) Crest of West Branch of Richmond Range, at crossing of principal boulder train	S. 54° E.
(4.) $\frac{1}{2}$ m. south of summit of Perry's Peak	S. 53° E.
(5.) $\frac{3}{4}$ m. S. S. E. " "	S. 60° to 70° E.
(6.) Crest of East Branch of Richmond Range, at crossing of principal boulder train	S. 70° E.
(7.) East slope of East Branch, $\frac{3}{8}$ m. N. N. W. from Miss Pearson's.	S. 55° E.
(8.) $\frac{1}{2}$m. N. E. of summit of Lenox Mountain	S. 45° E.
(9.) Summit of Lenox Mountain	S. 41° E.
(10.) Head of Cook Valley	S. 40° E.
(11.) $\frac{1}{2}$ m. N. N. E. from Mr. Werden's	S. 37° E.
(12.) Crest of West Branch of Lenox Range, $\frac{1}{2}$ m. E. S. E. of Mr. Werden's	S. 35° E.
(13.) West slope of Prospect Hill, Lenox	S. 45° E.

The localities numbered (1), (11) are worthy of special notice, as showing that such markings are not confined to the upper parts of the ranges.

An examination of the map will show that no localities of striæ are given upon either the chloritic schist and sandstone, or upon the limestone areas. Though the exposures of chloritic schist and sandstone

bear smooth surfaces, and the beds of limestone which outcrop in the valleys are rounded and water-worn, none of these rocks exhibit well-marked striæ. This peculiarity is probably due to the great amount of decomposition which the surface of these rocks has undergone.

In the case of the mica schists and argillites, the slight amount of decomposition which they have suffered, and the coarseness of the striations which they have received, have prevented the obliteration of the markings.

Though there is a great difference in direction between certain widely separated sets of striæ, yet it is generally true that the striæ situated upon the same N. E. and S. W. line, have, if not separated by a great distance, nearly the same direction.

4. SUPERFICIAL DEPOSITS UNDERLYING THE TRAINS.

The superficial deposits of the region consist of unstratified gravels made up of water-worn fragments of all sizes, and composed of limestone, quartz, quartzite, mica schist, chloritic schist, and chloritic sandstone. In a cut on the Boston and Albany Railroad, three quarters of a mile N. E. of Richmond Station, are completely rounded and polished boulders, some of which have a length of four or five feet. They are composed of limestone and of chloritic schist, and a few exhibit well-marked parallel striæ. The thickness of the drift deposits diminishes from the base towards the crest upon each of the three ranges in the region, the summits or crests being in nearly all cases free from this formation, though in several instances the bed-rock is concealed by a scanty soil bearing a thick vegetable growth.

The following table gives the thicknesses of the drift deposits in various localities.

Table of Thicknesses of the Drift.

(1.) Channel of brook between North and South "Families" of Canaan Shakers	20 feet.
(2.) Channel of same brook in ravine between Flat Rock and Merriman's Mount	25 "
(3.) Channel of brook near head of ravine between Merriman's and Dupey's Mounts	8 "
(4.) Channel of brook ¼ m. east of summit of Perry's Peak	8 "
(5.) Channel of brook ½ m. north of Haskell's, in the Haskell Valley (at least)	6 "
(6.) Channel of same brook ¾ m. nearly south of Haskell's	12 "
(7.) Channel of brook ½ m. S. S. E. of summit of Perry's Peak	3 "
(8.) Channel of same brook ½ m. N. N. W. of Miss Pearson's	8 "

(9.) Channel of same brook near bridge west of Mr. Salmon's..........	13 feet.
(10.) B. & A. R. R. cut near Mr. Oscar Smith's..................(at least)	26 "
(11.) B. & A. R. R. cut ⅜ m. N. E. of Richmond station.....(at least)	20 "
(12.) Channel of brook in ravine ¼ m. N. N. W. of Mr. Cook's in the Cook Valley..	11 "
(13.) Channel of brook at road crossing one mile N. E. of Mr. Cook's (at least)...	6 "
(14.) Channel of brook ⅝ m. west of summit of Prospect Hill...........	4 "

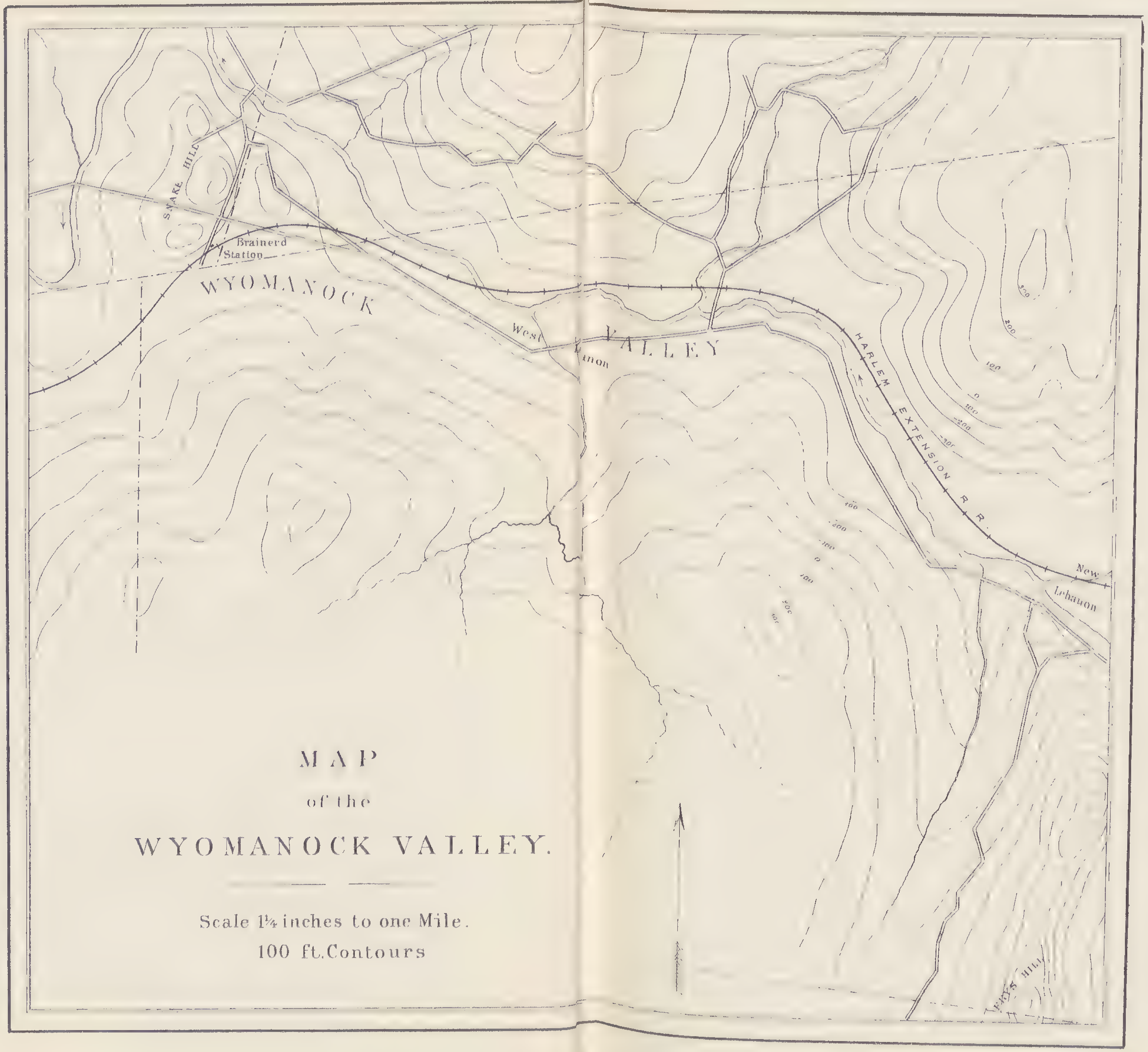
5. DESCRIPTION OF THE BOULDER PHENOMENA.

QUARTZITE BOULDERS.

On the western slope of the Canaan and Lebanon Range are many boulders of gray and green quartzite, those of the latter color predominating. These boulders are without definite arrangement, have suffered little abrasion, and do not exceed two feet in diameter. The probable origin of the green quartzite boulders is Snake Hill, an eminence situated about seven miles northwest of Fry's Hill, in the southeast corner of the town of Nassau, N. Y. (See map of the Wyomanock Valley.) Between Fry's Hill and Snake Hill the bed-rock consists of mica schist, a fine-grained, flaggy sandstone of a gray color, and a red shaly sandstone ; Snake Hill itself, consists of green quartzite, showing no signs of stratification.

The eastern declivity of Snake Hill is very precipitous, and at its base the ground is almost entirely covered with large angular blocks of quartzite like that of which the hill is composed. Going east and southeast from this locality, many of these angular blocks are seen scattered irregularly over the surface, and having a length of from one to five feet. One fourth of a mile south of Wheeler's Hotel, East Nassau, the main road passes between two angular masses of rock, which have each a length and height of 15 feet, being situated one fourth of a mile southeast of Snake Hill. Half a mile to the east and southeast an alluvial plain begins, and stretches east southeasterly up the valley of the Wyomanock Creek as far as New Lebanon.

From the vicinity of the large blocks just mentioned, down to the edge of the plain, the quartzite boulders are scattered quite thickly. The plain itself, however, is entirely destitute of them, but in the bed of the creek they occur in a number of spots in great abundance ; they are to be found also on the hills along the northern border of the plain, on the hills at its eastern end, and on the Canaan and Lebanon Range


SNAKE HILL
Brainerd
Station
WYOMANOCK
VALLEY
West
HARLEM EXTENSION R. R.
New
Lebanon
MAP
of the
WYOMANOCK VALLEY.
Scale 1¼ inches to one Mile.
100 ft. Contours

as far south as Fry's Hill. The hills to the west of this range along the southern border of the alluvial plain have not been examined, but from the facts just mentioned it is probable that boulders of this kind lie concealed beneath the detritus throughout the whole extent of that part of the Wyomanock Valley lying between Snake Hill and New Lebanon.

Boulders of gray quartzite have been mentioned as occurring along the western slope of the Canaan and Lebanon Range, and these seem to occur over all the region of the green quartzite boulders, besides being found also to the west of Snake Hill. It is probable that their origin might be found upon the hills lying still farther to the northwest.

Quartzite boulders, both green and gray, may be found in all parts of the Shaker Valley, upon the Richmond Range, and in the Richmond Valley; upon the Lenox Range also, and in the Lenox Valley they may be found here and there. Proceeding from Snake Hill to New Lebanon, and thence to Lenox Village and Lake Mahkeenac, the whole distance being seventeen miles, a continuous decrease in the number and size of the quartzite boulders may be noted, and also a continuous increase in the marks of abrasion which they bear.

CHLORITIC SCHIST BOULDERS.

a. PRINCIPAL TRAIN.

1. *Distribution.* — Upon Fry's Hill originates a train of boulders composed of the chloritic schist of which the hill itself is made up. From the summit of the hill the train descends in a S. 54° E. direction, then bends gradually to the southward, till at the base of the range, one fourth of a mile northwest of the North "Family" of Canaan Shakers, it has a S. 27° E. direction. From this point the train extends just south of the North Family, and up the face and along the crest of a westerly spur of the Richmond Range, called Merriman's Mount, to the crest of the Western Branch of the range. In so doing, it gradually changes its direction to S. 68° E., with which direction it crosses the upper end of the Haskell Valley, and begins the descent of the eastern slope of the Richmond Range. In making this descent, it bends considerably to the south, crossing the main road in Richmond two miles north of the railroad station, till it attains a S. 25° E. direction, near Mr. Oscar Smith's house, where it crosses the Boston and Albany Railroad. From the railroad the train continues on across the Richmond Valley with the same direction, passing near Mr. Werden's house in the southeast part of the town, and curving to the eastward as it mounts the western slope of the Lenox Range, crosses its two parallel ridges, and descends into the Lenox and Stockbridge Valley, where its direction is S. 50° E.

Beyond a point situated in the northeastern part of the town of Stockbridge, half a mile southeast of Mr. Luther Butler's house, near the Stockbridge and Lenox line, the train seems to lose its continuous character, the chloritic schist boulders in the same line to the southeast being few, small, and widely separated.

The different groups of chloritic schist boulders are represented on the map by red dots. They are not intended to show the exact number of boulders, or their size relatively to the other dimensions represented on the map. The position and width of the different groups, and the comparative abundance and size of the boulders in different localities, are, however, indicated with an approach to accuracy.

The profile of the section given below the map shows the irregularities of surface over which the principal train passes, as the section was taken very nearly along the course of that train, and is represented without exaggeration of the vertical scale.

The greatest depth of valley at the crossing of this train is, in the case of the Shaker Valley, 650, and in that of the Richmond Valley, 550 feet.

2. *Width.* — The train just described is perfectly distinct throughout its entire length, a distance of about nine miles. The following table shows its approximate width at various points.

Table of Widths of Principal Train.

(1.) Crest of West Branch of Richmond Range..............	430 feet.
(2.) Ten rods west of main road, Richmond..................	500 "
(3.) ½ m. N. W. of Mr. Oscar Smith's..........................	310 "
(4.) Brook draining the Cook Valley..........................	200 "

3. *Comparative Abundance of Boulders.* — From the summit of Fry's Hill to a point one fourth of a mile to the southeast of it, the chloritic schist boulders are so abundant as to almost entirely cover the foundation upon which they rest, while on passing along the train to the southeast, a well-marked, though not perfectly continuous, diminution in their number may be observed. The following table gives the localities where the boulders of this train occur in special abundance.

Table of Localities specially abounding in Boulders.

(1.) Eastern slope of Canaan and Lebanon Range.
(2.) Both sides of main road, Richmond, 2 m. north of R. R. station.
(3.) Bed of brook, ¼ m. S. W. of North Family of Shakers.
(4.) Crest of West Branch of Richmond Range.
(5.) ½ m. N. W. of Mr. Oscar Smith's.
(6.) Slosson and Werden farms, Richmond.
(7.) Southern slope of Prospect Hill (formerly).

Although the boulders have now been removed from the last locality to improve the land for agricultural purposes, there is reliable verbal evidence to show that they formerly existed there in abundance.

In the above table the localities are arranged in the order of the abundance in which they afford boulders, and by reference to the map it may be seen that they are thus at the same time in very nearly the order of their distance from Fry's Hill. By an estimate made as carefully as possible, the number of boulders in this train on the eastern slope of the Canaan and Lebanon Range appears to be about ten times as great as that on the same area in the Cook Valley.

4. *Size of Boulders.* — By far the largest boulders of this train are to be found on the eastern slope of the Canaan and Lebanon Range, two of them measuring 90 and 125 feet respectively in circumference, and being 30 feet in height. As close a calculation as can well be made gives the average length of the blocks in this vicinity as about 15 feet.

In the vicinity of Canaan Shakers the boulders average perhaps 12 feet in length, one on the east side of the road, between the North and South Families, having a circumference of 75 feet.

Two miles north of Richmond Station the boulders are of great size, two, mentioned by Sir Charles Lyell and other writers, being respectively 70 and 120 feet in circumference, the latter having, above the soil, a height of 20 feet.

Passing along the train as it crosses the Richmond Valley and the Lenox Range, a constant diminution in the size of the boulders takes place, till in the Lenox and Stockbridge Valley the average length is not over two feet.

5. *Shape of Boulders.* — The shape of the chloritic schist boulders is wholly irregular, and they are usually little modified by abrasion. None of those lying upon the surface are polished, though in the Lenox and Stockbridge Valley they are somewhat less angular than at the source nine miles distant.

b. Second Train.

About half a mile to the southwest of the train just described lies another, composed of the same kind of rock, but lacking the perfection and continuity of the first. The most westerly of the detached groups of boulders of which this train is composed, extends from a point on the eastern slope of the Canaan and Lebanon Range, one mile south of Fry's Hill, in a S. 53° E. direction across the Shaker Valley, and up the western and southern slopes of the spur called Dupey's Mount, to the crest of the western branch of the Richmond Range. This group has not the

well-defined limits which mark the principal train, hence its width cannot be so accurately given, though it may be stated approximately as 800 feet. The boulders of this group are only about half as numerous as are those upon an equal area of the corresponding part of the principal train.

Upon the eastern slope of the West Branch of the Richmond Range, in the Haskell Valley, is another group of chloritic schist boulders having a linear extension, but in a north and south direction, and again, upon the eastern slope of the East Branch, a similar distribution may be noted.

Passing southeasterly to the Congregational Church on the main road in Richmond, another group may be seen extending southeasterly from the church to a point half a mile distant, in the bottom of the Richmond Valley; here the detrital accumulations of the meadow cause a gap of an eighth of a mile, beyond which the train continues in a nearly southeasterly direction to a point about half a mile south of Mr. Slosson's house in the southeastern part of Richmond, beyond which it has not been traced.

In width and in abundance of boulders that portion of this train which extends from the Congregational Church to the point just mentioned resembles the corresponding portion of the principal train.

Between the different groups which make up this train are spaces destitute of chloritic schist boulders, and, unlike the principal train, this one does not extend to the crest of the Canaan and Lebanon Range.

The boulders of this train are, in general, smaller than those of the principal train. They, however, resemble those of the principal train in shape, in freedom from the effects of abrasion, and in exhibiting a diminution in size and numbers from the northwest towards the southeast.

c. Third Train.

Southwest of the second train lies a third parallel, but still more fragmentary, train. The most westerly of the detached groups of which it is made up lies upon the eastern slope of the spur next south of Dupey's Mount, and has nearly a circular form, with a diameter of about one third of a mile. Half a mile west of Mr. Haskell's in Richmond, E. S. E. from the first group, lies another small group on the south side of the road leading to Canaan, and half a mile north of Mr. Rossiter's, on the east side of the road, lies another in the same line with the first two. Again, half a mile to the southeast, near the Methodist Church in Richmond, another begins, and, passing just a few rods

north of the Richmond station, extends for a mile in a southeasterly direction.

A small group lies at the corner next south of the Cheever Ore Bed, while in Stockbridge, two miles southeast of this group, and one mile from Mr. Butler's, along the road running along the west side of Lake Mahkeenac to Curtisville, begins another group, which extends for a mile and a half in an E. S. E. direction, passing along the northern shore of Lake Mahkeenac, and finally dwindling away and becoming imperceptible at a point situated about half a mile east of the bridge which crosses the eastern angle of the lake.

The gaps in this train are still greater than those in the second, and the boulders are fewer and of smaller size. The largest boulders of the train, averaging ten or twelve feet in length, are in the most westerly group, and the smallest are in the most easterly, namely, along the shore of Lake Mahkeenac, where the average length is not over a foot and a half. In shape, and in freedom from abrasion, these boulders resemble those of the other trains.

d. Minor Train.

Another fragmentary train of chloritic schist boulders lies to the northwest of the principal train, its most westerly group being situated at the corners, a mile and a quarter north of Mr. Oscar Smith's, and the next being three quarters of a mile to the S. S. E., a few rods southwest of the bridge over the Boston and Albany Railroad. Half a mile east of Mr. Smith's is another group belonging to this train, at the northern end of a swamp which extends in a S. S. E. direction, while half a mile distant, at the southern end of the same swamp, another group begins, and extends for three quarters of a mile to the summit of the Western Branch of the Lenox Range. Upon the western slope of Prospect Hill, Lenox, lies a small group of boulders, which is the most easterly of this train that has been observed.

The boulders of this train are fewer than those of any of the others, there being, probably, not over a hundred in all, but in size, shape, and amount of abrasion they resemble those of the corresponding parts of the second and third trains.

e. Summary.

Not a single chloritic schist boulder was found west of the crest of the Canaan and Lebanon Range, and it is probable that the four trains which have now been described include all the boulders of that rock to be found within the region studied, except occasional boulders scattered

without definite arrangement between the trains. These, however, would not amount to more than one per cent of the whole number.

Only one distinct train of any considerable length can be traced, the others being quite fragmentary, and, though well defined in certain localities, in many quite indistinct.

The course of the trains is not dependent upon the inequalities of the surface, since it lies transversely across ranges of hills five or six hundred feet high.

It is not strictly true that the trains cross the ranges through gaps in the same.

Throughout the region it is generally true that, in any one locality, the direction of the trains coincides with the direction of the striæ in the immediate vicinity.

The general direction of the striæ and of the trains is S. 45° E.

There is a very marked diminution in the size and abundance of the boulders from the northwest to the southeast.

The boulders which make up the trains differ essentially from those contained in the underlying drift, since the former are angular, and almost wholly free from signs of abrasion.

Besides the chloritic schist boulders there are three other kinds, which, though of minor importance, are nevertheless worthy of notice.

CHLORITIC SANDSTONE BOULDERS.

Half a mile north of the summit of Perry's Peak, the highest point of the Richmond Range, are several boulders, ten or fifteen feet in length, which, at a little distance, closely resemble the chloritic schist boulders, but which prove to be in reality composed of chloritic sandstone similar to that of which Douglas Knob is made up. These boulders are worthy of mention on account of their elevation, which is 400 feet above their probable source, namely, Douglas Knob. A solitary boulder of the same kind of rock rests upon the same range, about a quarter of a mile southeast of the summit of Perry's Peak, at an elevation of 300 feet above Douglas Knob.

GRAY LIMESTONE BOULDERS.

A thin-flaggy, gray limestone has been referred to (page 23) as occurring on the western slope of the Richmond Range near the base, where it forms a narrow band running nearly north and south. On the east side of this band, in the towns of Canaan and Lebanon, are many boulders, usually oval in shape, composed of this kind of rock, while

throughout the town of Richmond occasional boulders of the same rock may be observed. Good specimens of boulders of this sort may be seen on the southern slope of Mount Osceola, a short distance southeast of Squire Bacon's.

BUFF LIMESTONE BOULDERS.

A compact buff limestone, with interlacing fissures on the weathered surface, has been referred to (page 23) as lying adjacent to the gray limestone just mentioned. The boulders of this rock have a distribution similar to that of the gray limestone boulders. One of them, eight feet in diameter, is situated upon the crest of the Western Branch of the Richmond Range, at the crossing of the principal boulder train, and another, six feet in diameter, occurs at a distance of one fourth of a mile S. S. W. from the summit of Perry's Peak. The former is 600, and the latter 800 feet above any known exposure of the same kind of rock in place.

SUPPOSED LIMESTONE TRAINS.

It was stated by Sir Charles Lyell and Rev. J. B. Perry that a number of limestone trains originated upon the Richmond Range, and extended across the Richmond Valley. (See references at beginning of this paper.) So far, however, as the observations of the present writer have extended, the Richmond Range is made up mainly of mica schist. There are, indeed, many rounded blocks of limestone in the Richmond Valley, chiefly along the western side, but they are confined to the limestone area, and there is no reason for supposing that they have been transported any considerable distance; it is probable, rather, that they were derived immediately from the underlying bed-rock, which they exactly resemble. They could hardly have originated upon the Richmond Range, since its only limestones are the two upon its western slope, and neither of them resembles the material of which the blocks in question are made up.

SUMMARY.

It is evident, from the relation which the present position of the chloritic schist boulders bears to their origin, that the transportation of glacial material in this region has been in general from the northwest towards the southeast.

Although all three of the ranges exhibit marks of glacial action wherever their bed-rocks are exposed, none of them afford trains of boulders except the Canaan and Lebanon Range. Fragments of mica

schist from all the ranges have indeed been transported southeasterly into the adjoining valleys, but such fragments are entirely devoid of linear arrangement.

CONCLUSIONS.

As boulders do not usually occur in trains, it is natural to inquire to what circumstances the Richmond boulder trains owe their formation.

The supposition of Sir Charles Lyell, that the boulders were transported to their present position by floating ice, has already been alluded to (page 18). It of course implies that the level of the ocean must have stood somewhat above the crest of the Canaan and Lebanon Range during the formation of the trains, or, relatively to the land, 1,650 feet above its present level. Other writers have shown that the same line of argument which leads to this conclusion would necessitate a depression of parts of the glaciated region to 5,000 feet below their present level, and they have also shown, from the absence of all marks of an oceanic shore line at that height, and from other considerations, that such a depression did not exist.

Boulders of chloritic sandstone and of buff limestone have been alluded to as occurring in the region under consideration upon the Richmond Range, those of the former rock being at a height of 400 feet, and those of the latter 600 and 800 feet above their source. Upon the iceberg hypothesis, the position of these boulders cannot be accounted for, except on the condition that the supposed ocean level rose several hundred feet in the interval of transportation ; and it seems quite improbable that so great a change of level could take place in the short time necessary for the transporting icebergs to float the boulders two miles, the distance of their farthest source.

Supposing, with most geologists of the present day, that this region, in common with a large part of the northern hemisphere, was, in the Post-Pliocene age, covered with an ice-sheet, which had in certain districts a thickness of several thousand feet, and had a slow movement, — in this vicinity from the northwest towards the southeast, — why, as a result of the rending action of the ice exerted upon the crest of the Canaan and Lebanon Range, are there not boulders of chloritic schist scattered nearly uniformly over all the region to the southeast of that range ? Such an arrangement might have resulted, had there been, at the time the material in question was being removed, a continuous outcrop of chloritic schist along the whole crest of the Canaan and Lebanon Range.

It seems possible to arrive at a satisfactory explanation of the origin of the trains by first considering the principal train, which is, of all the four, the most complete, and the one which reveals most unmistakably its origin. Fry's Hill, evidently the point of origin of this train, has been referred to as a sharp knob, situated on the crest of the range, and composed chiefly of chloritic schist. To the north and south of this knob, however, exposures of chloritic schist are wanting, the rock being chloritic sandstone and mica schist. It seems tolerably plain, then, that it is partly to the sharpness of the knob, and partly to the narrowness of the limits to which the chloritic schist is confined, that the narrow distinct train owes its formation.

The second train is, in all essential characters, like the principal train. Its direction in the Shaker Valley indicates that it originated upon a knoll situated on the crest of the range, half a mile S. S. W. from the origin of the principal train. It would be natural to expect to find that the train is continuous to this point, and that the knoll is composed, like Fry's Hill, of chloritic schist. On the contrary, it is composed of chloritic sandstone, and no chloritic schist boulders are to be found on its eastern slope. The explanation seems to be that the knoll once bore a mass of chloritic schist similar to that upon Fry's Hill, though much less in amount, and that, though it continued for a time to give off boulder material, the supply of chloritic schist in that spot was finally exhausted, the fragments having been all torn from the knoll, and at length deposited in their present positions.

In a similar manner the origin of the third and minor trains may be accounted for.

In what particular manner were the boulders transported by the ice-sheet? They either rested on its upper surface, or were dragged along between its lower surface and the bed-rock, or were imbedded in the mass of the ice.

The first of these suppositions cannot be sustained, since it presupposes cliffs upon the Canaan and Lebanon Range which reached above the surface of the ice, whereas an ice-sheet which could move across valleys six hundred feet deep, without being materially deflected from its course, must have covered the highest land in the region to the depth of many hundred feet.

The second supposition is equally invalid, since, if these boulders had been dragged along under the ice, they would of necessity be much abraded, most of them showing smoothed surfaces, which would be likely to bear striæ. None of these effects are to be found upon them, how-

ever, the nearest approach to them being a slight rounding of some of the sharper corners and edges. It seems evident that these boulders have suffered none of that extreme abrasion which would have been caused by friction against the bed-rocks.

It is probable, then, that the boulders of the trains were removed from their original bed by the lower surface of the ice-sheet, and became imbedded in the mass of the ice instead of being dragged along beneath it. This supposition is in harmony with the observed sharpness of the knob called Fry's Hill, the origin of the principal train, since boulders torn from its upper part would be at least 100 feet above the lower surface of the ice-sheet along the neighboring parts of the crest, and the ice, closing together again as soon as it had passed the sharp knob, would hold many of them firmly without allowing them to work down to the rocks below.

Two great deviations from the normal course may be observed in the boulder trains, especially in the principal one. If that part of the ice containing the boulders had met with no deflecting force, it would have preserved a rectilinear path in a S. 50° E. direction. The maxima of deviation from the normal course are on the western spurs of the Richmond Range, and on the western slope of the Western Branch of the Lenox Range, and they show by their positions relative to Perry's Peak and Lenox Mountain that these mountain masses were the obstacles which temporarily turned aside the boulder trains from their normal course.

The second, third, and minor trains exhibit gaps, caused probably by the temporary failure of the ice to get hold of any of the rock material; the tough schist resisted successfully for a time the efforts of the ice to tear it from its bed; then a mass was obliged to yield to the prolonged strain, and, becoming loosened, the resulting fragments were borne away. The rock left behind, being still firmly fixed in its place, would in its turn resist for a time, thus causing another gap in the train, till in time another mass would be obliged to yield to the rending action of the ice, and so the process would go on.

The sharper the knob the narrower the train to which it gave origin. This statement is well illustrated by the fact that the southeasterly parts of the second and third trains, which were given off at first when the knobs were sharp, are quite narrow and distinct, while the more northwesterly parts of the same trains, which were given off later, when the knobs had become somewhat rounded, are very much broader.

A diminution in the size of the boulders towards the southeast has

been referred to, and this diminution is accompanied by a decrease in the number of boulders. It is common to see two boulders side by side which evidently were once parts of the same boulder, the fragments having been separated from each other by the action of frost. The fissure by which the frost entered was probably started by the shattering action of the ice-sheet, while the mass still formed part of the bed-rock, and undoubtedly many, if not all, of the fragments torn off by the ice contained incipient fissures, which were afterwards developed by the crushing force of the glacier. This being the case, the fragments would be crushed finer as they receded from their source, and the diminution in size, which has been alluded to, would be brought about.

Under the influence of gravity, the imbedded fragments would be constantly working down towards the under surface of the ice-sheet, and thus, the farther from the source the greater the amount of material lost from the trains and added to the material destined to be ground up beneath the ice.

On looking at the map, it will be observed that the general direction of the ridges and valleys is N. N. E. and S. S. W. It has been suggested to the writer by Professor Shaler that, although the stratigraphical relations of the limestones and schists have, in the main, determined the topographical features of the region, there are peculiarities in the present contour of the surface which cannot be accounted for by stratigraphical and ordinary erosive agencies, and that the mountain ranges and valleys give evidence of having been largely molded by glacial action. Professor Shaler considers that the direction of glaciation at that time was much the same as the present course of the ridges, namely, from N. N. E. to S. S. W., and thinks it likely that the shape of these valleys may indicate that in glacial periods anterior to the Post-Pliocene age the form of the continent was such that the ice found its outlet towards the region lying to the west of south, rather than towards the southeast, as in the last glacial period.

The perfection of the principal train indicates that it, at least, was deposited at the time of the melting away of the last general ice-sheet which covered the region, since any glacial sheet moving over the region after the deposition of this train would have obliterated it. There may have been local glaciers in the subordinate valleys at a subsequent period, though no evidence of them was observed. As remarked by Professor Shaler, such glaciers, had they existed, would not have interfered with the continuity of the principal train, since it crosses the main valleys upon "cols," where it would have been exposed

to the névé only of any local glaciers which might have formed in the north- and south-sloping valleys on each side of the "cols."

An amount of chloritic schist vastly greater than is represented by the trains may have been removed by the ice from the crest of the Canaan and Lebanon Range, but all, except the boulders of the trains, has been more or less ground to pieces in the glacial mill, and is now imbedded in that formation which has been the ground moraine of one or more general ice-sheets.

The facts connected with the Richmond Boulder Trains throw little, if any, additional light on the explanation of glacial phenomena in general, but the theory of a general ice-sheet, as it is received by most geologists, seems competent to explain, in considerable detail, not only the origin, but most of the marked peculiarities of the trains, and in so far as it does this, it receives fresh confirmation from the facts which have been stated.

NOTE A.

METHOD OF MAKING THE SURVEY.

The positions of the town boundaries, roads, streams, and ponds of the region, and the position of a pole on the summit of Perry's Peak (determined by the United States Coast Survey) were obtained from Walling's Map of Berkshire County, Mass., and from Beers's Atlases of Columbia and Van Rensselaer Counties, N. Y. The positions of the pole on Perry's Peak and of the intersections of the roads were assumed to be correctly determined, and the positions with reference to these points, of various buildings throughout the region, were fixed as accurately as possible by pacing. The geographical positions of the important points on the mountain ranges were obtained by taking bearings on buildings, the positions of which had been determined as before stated, care being taken to have the bearings as nearly at right angles as possible. The geographical positions of the contour lines and of the boulder trains were fixed partly by the above method and partly by measurements along the roads.

The height of Richmond station above the sea (1,050 ft.) was obtained from the profile of the Boston and Albany Railroad, which is kept at the superintendent's office in Boston. The heights of the mountain ranges and of the contour lines above Richmond station were measured with an aneroid barometer, the instrument used having been tested in various ways and found to register heights with considerable accuracy, and the necessary corrections being applied to the measurements which were taken.

No high order of accuracy is claimed for a survey made in this manner, but it is sufficiently accurate to serve the purpose for which it was made.

NOTE B.

MICROSCOPIC ANALYSIS OF ROCKS.

BY MR. M. E. WADSWORTH.

The following table gives the localities from which the specimens which were studied microscopically were taken : —

No. 1. Boulder near Mr. Werden's, S. E. part of Richmond.
" 3. " " " "
" 4. Bed-rock, summit of Fry's Hill.
" 5. " crest of ridge, near Douglas Knob.
" 12 and 13. Bed-rock, west end of ravine between Flat Rock and Merriman's Mount.
" 17. Bed-rock, west slope of Merriman's Mount.
" 21. " N. E. side of Perry's Peak.

Mr. Wadsworth says of these specimens: "Nos. 1, 3, 4, 12, 13, and 17 are chlorite schists, composed principally of chlorite in leaves, granules, and fibres, the fibrous forms predominating. The chlorite is of a light or brownish-green color. Kaolinized feldspar is also very abundant; the other minerals being opacite, brown mica, and pyrite; the opacite arising partly from the alteration of the pyrite. These schists are evidently much metamorphosed.

"No. 21 is a chloritic mica-schist, very fine-grained, and made up chiefly of a ground mass of chloritic matter holding numerous irregular flakes of brown mica, and a very few grains of quartz.

"No. 5 is a chloritic sandstone composed of quartz grains and chlorite, with some kaolinized feldspar and crystals of magnetite. The quartz contains fluid inclusions, and in some of the grains occur the long black microlites, so common in the quartz of granites. This, together with the form of the grains, would indicate that the sandstone was derived from the disintegration of granitic rocks."

NOTE C.

REMARKS ON THE STRATIGRAPHICAL GEOLOGY.

The distribution and lithological characters of the different bed-rocks in the region has already been given (page 22). The distribution is also indicated on the map by geological colors, and the direction of the dip is indicated by arrows, the small circles on the arrows marking the spots where the observations were taken.

The limits of the band of chloritic rock, which is represented on the map as extending along the crest of the Canaan and Lebanon Range, could not be ascertained with certainty, but wherever exposures were observed along the crest, a rock entirely different from that of the great mass of the range was found. This rock has a decided green color, is very compact, and cannot be split into thin plates, and this assemblage of characters distinguishes it at once from all the other rocks of the region, except the narrow band of the same rock on the other side of the Shaker Valley. Two typical exposures of the rock in this band have been described, namely, the chloritic schist of Fry's Hill, and the chloritic sandstone of Douglas Knob; how much of the band is made up of each kind of rock, it is, from lack of a sufficient number of exposures, impossible to determine.

The limits of the two narrow bands of limestone on the western slope of the Richmond Range are not known with certainty, the location of one of the bands being based on only two, and that of the other on only three exposures.

The boundaries between the schists of the Richmond and of the Lenox Range and the limestone of the Richmond Valley were fixed with tolerable certainty, also that between the schist of the Lenox Range and the limestone of the Lenox Valley, although along none of these boundaries was the direct contact of the two rocks observable.

Wherever the direct contact was found, however, namely, in the southeast corner of the town of Lebanon, and at Humphrey's Quarry, in the southern part of the town of Pittsfield, the folia of the mica schist were found to lie in planes parallel to the planes of bedding of the limestone, and in the latter locality the limestone and mica schist were distinctly interbedded. There is every appearance, throughout the region, of the different formations being conformable with each other, and they are so represented in the section below the large map.

In all parts of the region where good observations could be taken, with one exception, the rocks dip steeply in directions between E. S. E. and east. There are irregular variations of the dip ranging from 30° to 80° in different parts of the same formation. The average dip along the section is about 60°, and, provided there were no faults or folds in the region, the beds would have a thickness of 34,000 feet, or about 6½ miles. An exception to the almost universal easterly dip has been alluded to. This exception occurs in the vicinity of Mr. H. Salmon's house, near the northwestern border of the Richmond limestone area. In a small ravine just west of Mr. Salmon's is to be seen an anticlinal arch in the limestone, the axis running N. N. E., and a quarter of a mile northeast of Mr. Salmon's is a portion of another anticlinal, the axis of which is parallel to, and about a quarter of a mile east of that of the former.

According to Professor J. D. Dana ("Geology of Vermont and Berkshire," Amer. Jour. Science, July to October, 1877) the limestones of Berkshire County lie in extremely eroded anticlinals, while the schists occur in the shape of less eroded synclinals which rest conformably on the limestone. Different degrees of flexure in the anticlinals and synclinals are to be observed in different localities throughout the county, in some of them the flexure being so extreme that the strata are folded double, with the planes of the folds dipping to the east, the strata of those portions of the folds which have not been removed by denudation presenting the appearance of interstratification.

So far as the facts observed in the region of the Richmond Boulder Trains are concerned, it seems that the structural relations of that region may be explained in accordance with Professor Dana's views. The three great masses of schist in the three parallel ranges lie in extremely flexed synclinals, which are contained between the anticlinal folds of the three great limestone belts. The limestone belts are continuous with each other beneath the ridges of schist, and the different masses of schist were once a continuous stratum overlying the limestone, but have become separated through the loss by denudation of the anticlinal portions of their folds.

According to Professor Dana,* the Berkshire limestones are part of the continuous belt of that rock which extends through the western part of Connecticut, Massachusetts, and Vermont, the portion in Vermont being called the Eolian limestone. The limestone in Massachusetts is of the same age as the Eolian limestone in Vermont. From the fossils discovered in the Eolian lime-

* Amer. Jour. Science, Vol. XIV., 1877, p. 37.

stone by the Rev. Augustus Wing, that formation is determined to be of Lower Silurian age, and to represent rocks not older than the Cambrian, and not newer than the Trenton.

In Vermont the rocks of a belt of slate which is continuous with the schists of the Richmond Range in Berkshire County, are found to overlie the Eolian limestone, and thus the slate series is more recent than that formation, and is considered to represent the Hudson River slates.

On these grounds, Professor Dana concludes that the limestones of Berkshire are of Calciferous, Quebec, Chazy, and Trenton age, while the schists are of the age of the Hudson River slates.

On the supposition that the limestone of the Richmond Valley represents a series of beds bent double, the thickness of the series is at least 5,000 feet, and on the same supposition the thickness of the mica schist series in the Lenox Range is 4,500 feet, making 9,500 feet of Lower Silurian strata.

May 15, 1878.

MAP OF THE
RICHMOND BOULDER TRAINS.
SURVEY AND MAP BY
E. R. BENTON.
1878.
Scale 2½ inches to one mile.
100 ft. Contours.
The figures on the contours indicate the height in feet above the Richmond Station on the Boston and Albany Railroad the station itself being 1050 feet above the sea level.
Mica schists and micaceous argillites
Limestones.
Chloritic schist and chloritic sandstone
Chloritic boulders
The arrows indicate the direction of the dip
The short parallel dotted lines indicate the direction of the striae.
CANAAN AND LEBANON RANGE
LEBANON
HANCOCK
PITTSFIELD
RICHMOND POND
WHITING'S POND
CANAAN
RICHMOND
LENOX
WEST STOCKBRIDGE
STOCKBRIDGE
LAKE MAKEENAC
Section
Section along the line marked Section I upon the map.
Vertical Scale same as horizontal
FRY'S HILL. Chloritic schist.
Micaceous argillite
Limestone. SHAKER VALLEY.
Limestone.
Chloritic schist.
Limestone.
RICHMOND RANGE. Mica schist.
RICHMOND VALLEY. Limestone.
LENOX RANGE. Mica schist.

No. 4.—*Description of a new species of* Corbicula, *with Notes on other Species of the* Corbiculadæ *Family. By* TEMPLE PRIME.

Corbicula Moltkiana, nov. spec.

Pl. II. Fig. 2, a, b, c.

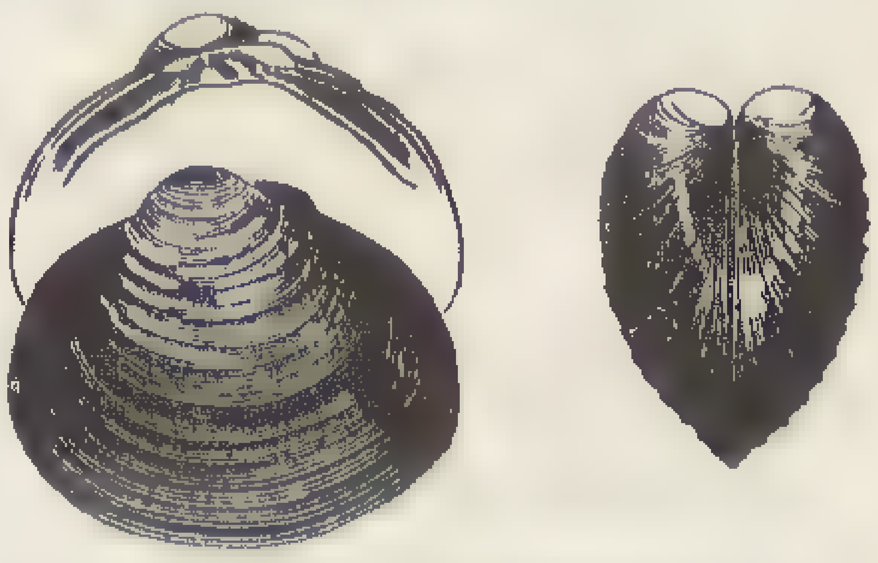
C. testa lævis, transversa, compressa, subæquilaterali; latere antico breviore, rotundato, postico obtuso; umbonibus brevibus, obtusis; lunula vix conspicua; epidermide nigro-fuscescente, nitente vestita; striis elevatis, regularibus; margarita violacea.

Long. 25; lat. 20; diam. 12 mill.

HAB. Sumatra.

COLLECT. University of Copenhagen (two specimens).

Compared with *Corb. ducalis,* from Java, it is less heavy, less inflated, transversely less rounded, and the striæ are less distant.



Corbicula ducalis.

I know of but one other species of *Corbicula* from Sumatra, the *pullata,* of Philippi, which, judging from the description, must be more spherical and more trigonal than my species.

Count Moltke, of Denmark, to whose memory I dedicate this species, was the possessor of one of the finest collections of his day, which, at his death, towards the end of the last century, he left to the University of Copenhagen.

Cyrena pullastra, MÖRCH.

Pl. II. Fig. 3, a, b, c.

Grena (Polymesoda) pullastra, Mörch. Malak Blätt. VII. 194, 1860. Smith. Inst. Prime, Mon. Corb. 26, 1865.

C. testa ovalis, tenuis, albescens, radiatim subtilissime striata, valde inæquilateralis, convexiuscula, antice brevissime angustata, postice late rotundata, margo dorsalis anticus precipite declivis, posticus rectus fere horizontalis, postice angulo obtuso; margo ventralis parum arcuatus; area postice violacea tincta; dens lateralis posticus valvæ sinistræ remotissimus, compressus inter laminas 2 valvæ dextræ receptus; dens anticus subapproximatus; sinus syphonalis angustissimus, sursum spectans.

Long. 30; lat. 23; diam. 14 mill.

HAB. Central America, at Realejo, in Nicaragua.

COLLECT. University of Copenhagen (one specimen).

This species never having been figured, I had a drawing made of it during my stay at Copenhagen. The only known specimen of this species, the one at Copenhagen, is considerably worn and nearly colorless.

Velorita parvula, Prime.

Pl. II. Fig. 4, a, b, c.

Velorita parvula, Prime. Ann. Lyc. N. H. N. Y. VIII. 418, 1867.

V. testa tumida, subtrigonali, cordiformi, valde inæquilaterali; latere antico latiore, semicirculari, postico recto, declivi; umbonibus brevibus, incurvis; lunula vix conspicua; epidermide olivaceo-fuscescente, nitentissime vestita; striis regularibus, postice evanescentibus; cardine angusto; valvis læviusculis, intus pallide cœruleis, fusco maculatis; sinu syphonalis brevi.

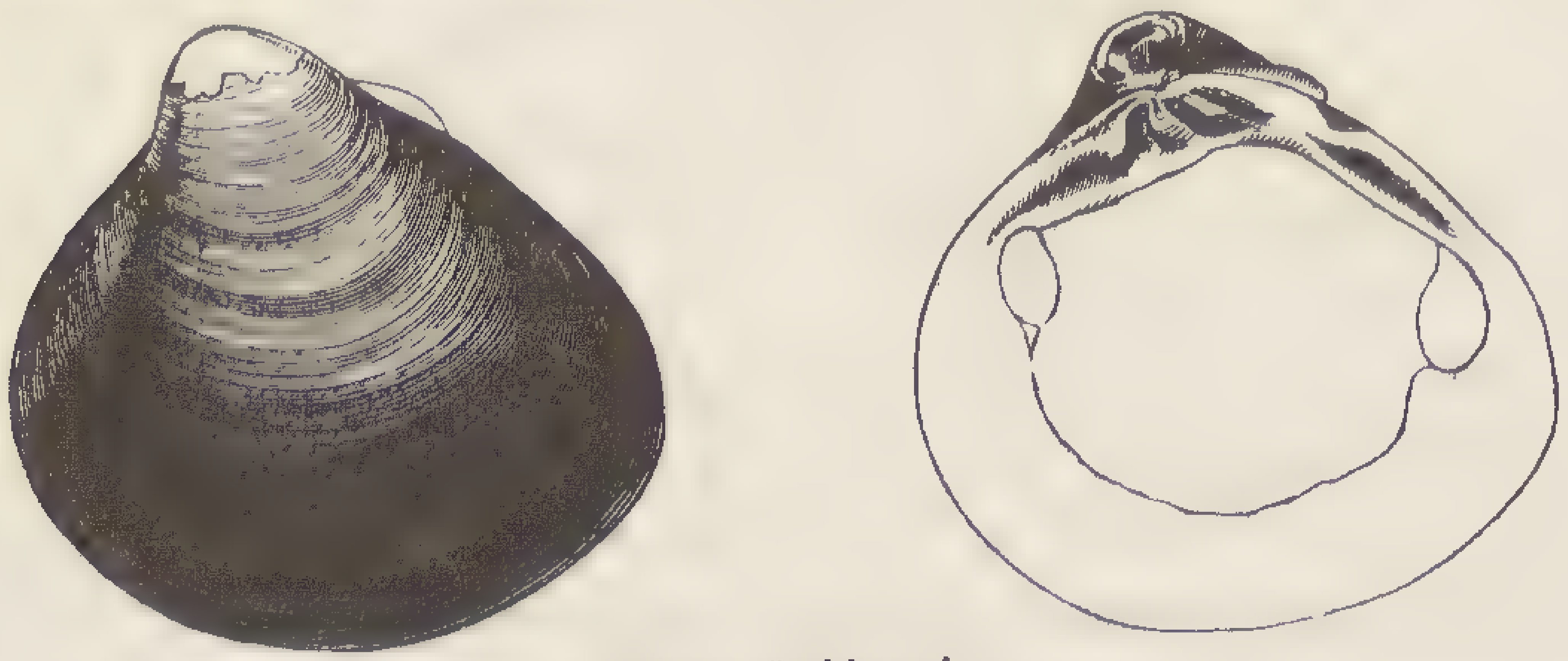
Long. 35; lat. 31; diam. 19 mill.

HAB. ?

COLLECT. Prime; University of Copenhagen (two specimens).

During an examination I was making (1872) of the collection of the University of Copenhagen, I discovered a *Velorita*, which I was able to identify as the adult of a species (*parvula*) which I had described from the young only. There were three specimens in the University, one of which was very kindly presented to me.

The *parvula*, compared with *Cochinensis*, is very much less ponderous



Velorita Cochinensis.

and less trigonal; it is larger than *Cyprinoides*, but less ponderous and less trigonal. The hinge of my species is much narrower and less solid than that of either *Cochinensis* or *Cyprinoides*.

Batissa lævigata, Schumacher.

Pl. II. Fig. 5, a, b, c.

Cyclas lævigata, Schumacher. Schum. Essai d'un nouv. syst. 170, Pl. XII. Fig. 1, 1817.
Cyrena Childrenæ, Gray. Ann. Phil. 117, 1825.
Venus Childreni, Gray. Wood, Index Test. suppl. Pl. 2, Fig. 13, 1828.
Batissa Childrenæ, Deshayes. Brit. Mus. Cat. Conchif. 237, 1854.

B. testa ovato-subrotunda, obliqua, inæquilaterali, depressiuscula, crassa, solida, postice ab umbonibus obscure subangulata, epidermide fusco-viridi nitente induta, intus pallide violacea; latere antico breviore, obtuso, transversim inæqualiter sulcato; sulcis in medio evanidis; latere postico latiore rugis irregularibus divergentibus notato, lamina cardinali lata, crassa, dentibus primariis tribus inæqualibus, in utraque valva medianis validioribus; dentibus lateralibus subæqualibus, antico basi lato.

Long. 38; lat. 34; diam. 16 mill.

Hab. Philippine Islands (fide Deshayes).

Collect. University of Copenhagen (one specimen, Schumacher's type). Brit. Mus.; Prime.

While in Copenhagen (1872), I was able, thanks to the courtesy of the late learned Mr. Mörch, to examine, in the collection of the University, the type of Schumacher's *Cyclas lævigata* (which I have figured, Pl. II. Fig. 5). Schumacher's shell I found to correspond in every respect with a species which had been subsequently described under the name of *Childrenæ*.

Pisidium Steenbuchii, Möller.

Pl. II. Fig. 1, a, b, c, d, e.

Cyclas Steenbuchii, Möller. Natur. Tid. IV. 76. 1842.
Sphærium Steenbuchii, Deshayes. Brit. Mus. Cat. Conchif. 264, 1854.
Pisidium Steenbuchii, Mörch. Prod. Moll. Grönl. 19, 1857.
Pisidium fontinale. Midd. Reise.
Pisidium Steenbuchii, Mörch. Am. J. Conch. IV. 37, Pl. IV. Fig. 10, 1868. Mart. and Chemn. Cycladea, 35, Pl. 3, Figs. 21, 22, 1877.

P. testa oblique-ovalis, ventricosa, striis incrementi subtilissimis; cinereo lutescente; intus cinerea; umbonibus prominentibus.

Long. 4; lat. 3; diam. 3 mill.

HAB. North Greenland, north of Baal's River.
COLLECT. University of Copenhagen ; Prime.

I took occasion, while in Copenhagen, to have a drawing made of this species from one of Möller's original types.

Closely allied to *P. pulchellum*, but the lines of growth are finer, although the shell is larger.

Clessin, in his synonymy of this species,[1] is at fault ; he ignores my first four references, and makes it out that this species was first described in 1868,[2] and not by Möller as a *Cyclas*, but by Mörch as a *Pisidium*, which is not correct.

1 Mart. and Chemn. Cycladea, 35, 1877.
2 Am. J. Conch. 1868.

1 *Pisidium Steenbuchii*, Möller. type
2 *Corbicula Moltkiana*, Prime.
3 *Cyrena pullastra*, Mörch. type
4 *Velorita parvula*. Prime
5 *Cyclas laevigata*, Schum. type

C. Thornam del. & sc. Hafniæ

No. 5. — *Notes on the Anatomy of Corbiculadæ (Mollusca), and a Translation from the Danish of an Article on the Anatomy of* Cyclas (Sphærium) *by* JACOBSEN. *By* TEMPLE PRIME.

BUT little has been written on the anatomy of *Corbiculadæ*. Gray (1853)* gave a description of the soft parts of the genera *Corbicula, Batissa, Cyrena, Sphærium,* and *Pisidium;* but these notices do not come strictly under the head of anatomy.

The first truly anatomical article we have on this family is one published (1828) † by Jacobsen of Copenhagen, on the anatomy of *Cyclas (Sphærium) cornea.* This memoir being in Danish has necessarily been accessible to but few, and I have thought it would not be ill-judged to have it placed before our naturalists, and consequently have translated it into English. This article, I will add, was reviewed, in 1830, in the twenty-third volume of the Bulletin des Sciences Naturelles. The next article we have is the development of *Cyclas calyculata* (*Sphærium lacustre*) by Oscar Schmidt, in 1854 ;‡ following upon this, we have the anatomy of *Cyclas* (*Sphærium*) *cornea*, by Franz Leidig in 1855 ;‡ both these articles are also too little accessible, and at some future time I propose translating them.

Mr. Fischer of Paris, in 1863, § published the anatomy of *Corbicula Largillierti.* This article was translated into English in 1867 ;|| the same author published, in 1872,¶ an article on the anatomy of *Cyrena Caroliniensis* and of *Cyrena Floridana.*

The articles enumerated under the heads 6 – 9 also give incidental notices concerning *Sphærium* and *Pisidium.*

As far as my information goes, this is all that has been written on this subject.

Summary.

1. Cycladens anatomiske Undersögelse. L. Jacobsen, K. Dansk. Selsk. Naturvid. Afhandl. Vol. III. 1828, pp. 303 – 323, Pl.

2. Ueber die Entwicklung von *Cyclas calyculata,* Drap. Oscar Schmidt, Müller's Archiv, 1854, pp. 428 – 438, Pl. XVI.

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* Brit. Mus. Cat. Conchif.

† Proc. Royal Danish Soc. Nat. Sci. Vol. III.

‡ Müller's Archiv.

§ J. Conchyl. Vol. XI.

|| Ann. Lyc. N. H. N. Y. Vol. VIII.

¶ Ann. Lyc. N. H. N. Y. Vol. X.

3. Ueber *Cyclas cornea*, Lam. Franz Leidig, Müller's Archiv, 1855, pp. 47 – 66, Pl. VI. Figs. 8 – 18.

4. Sur l'anatomie des Cyrènes. P. Fischer J. Conchyl. Vol. XI. 1863, Pl. IV.*

5. Note sur l'anatomie des Cyrènes Américaines. P. Fischer, Ann. Lyc. N. H. N. Y. Vol. X. 1872, Pl. VIII.

6. Beitrag zur Lehre von den embryonalen Blättern bei den Mollusken. M. Ganin Warschauer Universitäts-Berichte, 1873, No. 1, 115 – 171. (*Cyclas* (*Sphærium*) considered.)

7. Contributions to the Developmental History of the Mollusca. E. R. Lankester, Ann. N. H. XIV. 81 – 86, and 458 – 460 ; also P. R. Soc. XXII. 232 – 238, 1874. (On the embryonic development of *Pisidium*.)

8. On the Coincidence of the Blastopore and Anus in Paludina vivipara. E. R. Lankester, G. J. Micr. Sci. XV. 159 – 163 ; XVI. 377 – 385, Pl. XXV. 1875. (*Pisidium* considered.)

9. Sketches to a scale of the Auditory Organs of certain Common Mollusks. G. Gulliver, Il. of Anat. and Physiol. 1869, 79 – 81, Pl. 2, Fig. 3. (*Cyclas* (*Sphærium*) *lacustris*.)

* Translated into English. Ann. Lyc. N. H. N. Y. Vol. VIII. 1867.

The Anatomy of Cyclas (Sphærium). *By* L. Jacobsen.

The soft parts of *Cyclas* (*Sphærium*) *cornea*, compared with the size of the shell, are, relatively speaking, small. Opening the valves from below, we find the gills on each side, and the inner walls of the valves lined by the mantle (Pl. III. Fig. III.).

The mantle, composed of very delicate membranes, envelops the soft parts; it is open from the anterior to the posterior adductor muscles: the free edge is thick, compact, free from filaments, and dark in color; it is prolonged over the adductors, and follows the dorsal outline of the animal (Pl. III. Fig. IV.). At the anterior and posterior points of the mantle opening, and within the edges, there is a transverse membrane which binds them together; at the anterior point it is small and crescent-shaped (Pl. III. Fig. IV. *b*–*h*); at the posterior point it is larger and of peculiar shape, it extends from the point where the edges of the mantle are united to the posterior adductor, and occupies a third of the edge (Pl. III. Fig. IV. *i*, *k*, *l*; III. *c*). We find in this membrane two circular apertures, the superior one of which is the smaller. This membrane, when distended, assumes the shape of a cylinder, and terminates in two tubular apertures, encircled by delicate filaments. These two apertures are the respiratory canals, by means of which the animal takes in and expels the water necessary to this function (Pl. III. Fig. V.); the superior aperture leads to the canal of the gills, and the inferior one to the cavity of the mantle; the filaments encircling the apertures are very sensitive, the least contact causes the tubes to contract and the valves to close (Pl. III. Fig. II. *b*).

In addition to the adductor muscles, we have the foot, which when contracted has somewhat the shape of a ploughshare (Pl. III. Fig. VI. *a*); it is capable of greater distention than is usually the case with that of fresh-water mollusks, and when at its greatest distention it is twice as long as the shell itself; posteriorly it is triangular, anteriorly it is more rounded, below it is quite flat; in many respects it recalls the foot of *Helix*, as well in shape as when in action; it is white, and the anterior end is encircled by a beautiful rose-tinged band (Pl. III. Fig. I. *b*). The foot is attached to the abdomen by means of solid and strong filaments, which originate on each side of the valves near the posterior adductor and run to the anterior adductor; the ligaments along the abdomen circumscribe it, and serve, probably as in other mollusks, as a means of attachment for the muscles of the foot and for the membrane which surrounds the abdomen (Pl. III. Fig. IV. *b*).

With regard to the organs contained in the abdomen we will first examine the organs of digestion. The mouth in *Cyclas* (*Sphærium*), as in *Anodonta*, is situated on the anterior edge of the abdomen, immediately below the anterior adductor; it is circular, and is surrounded by four triangular, sharp, flat tentacles of equal size (Pl. III. Fig. IV. *c*, *d*; Fig. VIII. *b*, *c*). The stomach is surrounded by the liver. The intestine makes in the first instance several curves, it then passes through the ovaries to the posterior side of the abdomen, thence somewhat towards the anterior and in an upward direction to the dorsal margin, where it makes its last curve and then returns in a somewhat downward direction, thence through the heart and over the posterior adductor, where it terminates in the anus (Pl. III. Fig. VI. *f*, *g*, *h*; Fig. IV. *h*, *o*). The course of the intestine may be readily traced, as its base is frequently filled with a dark greenish substance, and as the membrane of the abdomen is somewhat transparent.

The liver is large, it occupies the forward and upper part of the abdomen, it surrounds the stomach; its position and its structure recall those of *Anodonta*, though its outline is relatively much larger (Pl. III. Fig. IV. *p*; Fig. VI. *e*).

The organs of touch have already been alluded to; they are the feelers around the mouth, the tentacula, and the filaments which encircle the tracheæ. With regard to their nervous system, we distinguish distinctly the anterior pair of ganglions, situated behind the tentacula, and two filaments of nerves which follow the sides of the abdomen to the posterior ganglions, which are smaller than the anterior ones (Pl. III. Fig. VI. *a*, *β*, *ν*). The membrane covering these organs is yellowish.

With regard to the organs of circulation, we have only been able to make out the form of the heart and its situation, which are the same as in *Anodonta*; the heart may be readily seen through the membrane of the mantle covering the dorsal part of the animal. As already stated, the rectum runs through the heart (Pl. III. Fig. IV. *n*).

We now come to the respiratory organs, the gills, which in this genus present a very curious formation.

As is well known, all bivalves have two pairs of gills, the exterior ones and the interior ones, which are of about the same size and run parallel to each other. Consequently it is rather remarkable to observe that in this genus the interior gills overlap the exterior ones, and are, apparently, double their size. This difference, however, is only apparent, as the interior gills stand in the same proportion in size to the exterior

ones as they do in *Anodonta;* they appear larger on account of the prolongation of the membranes uniting them to the mantle and to the abdomen.

It is generally understood that in *Acephala* the gills are formed by two closely united membranes connected on the convex edge; at the upper edge of the gills these membranes separate and are attached to the mantle or to the mantle and the lateral parts of the abdomen; this structure gives rise to a triangular canal, which follows the superior edge of the gills and is the true gill-canal. This gill-canal is more developed in the exterior pair than in the interior pair; in the interior gills it seems that the internal membrane of the gills, which should form the canal, is only attached to the interior and posterior portion of the abdomen, and covers the intermediate portion, without, however, being connected with it; the result is that the interior gills possess a longitudinal aperture situated at the uppermost portion of the abdomen. The canal of both pairs of gills is united at the posterior extremity of the gills, and forms a short common canal. The gill-canals of several *Acephala* are constructed in this manner; more especially is this the case in *Anodonta.*

The result of our investigations on the structure of these organs in *Acephala* in general holds good also with the genus *Cyclas* (*Sphærium*), especially so as concerns the exterior gills, but an examination of the interior gills shows a modification.

That portion of the external and internal membrane of the gills which forms the gill-canal, and which unites the gills to the mantle and body of the animal, instead of being very narrow, as is usually the case in *Acephala*, is so large that it overlaps the gill to the extent of double its size; consequently, in place of a narrow gill-canal, we find a cavern. This cavern is anteriorly broad, posteriorly narrow, and terminates in a small narrow passage, which is connected with the common gill-canal, and is attached to the inferior aperture of the posterior transverse membrane of the mantle (Pl. III. Fig. VII., VIII., IX.); at this point there is found a large crescent-shaped aperture, corresponding to the lateral aperture of the interior gill-canal, as is the case in *Anodonta*, and this is due to the fact that the internal membrane of the canal is not attached to the central portion of the abdomen (Pl. III. Fig. VIII. *g*).

The sac formed by these membranes extends on each side far beyond the exterior gills, and the interior gills are attached to it; consequently it does not run parallel to the exterior gills, but runs from in front and from below, to the rear and upwards, at which point it comes in contact

with the rear end of the exterior gills, which follow an opposite direction (Pl. III. Fig. VII.).

The size, the form, and the structure of the interior gills are precisely as in *Anodonta.* The small conical divisions, or cylindrical cavities, which are found between the membranes, open into the distended canal, which henceforward we shall term the gill-sac (Pl. III. Fig. VIII., IX).

An examination of its membranes under the microscope reveals the existence of delicate parallel lines running from above downwards; they extend also over portions of the gill proper, and are due probably to the blood-vessels uniting them. I could not detect between these lines the existence of the delicate transverse lines generally found on the gills. The convex edges of the gills exhibit delicate protuberances (Pl. III. Fig. VII., VIII., IX., X.).*

Coming to the generative organs, I have been able to make out the ovaries only; they are on the sides of the abdomen, in the rear, and they are bounded anteriorly by the liver and the large curves of the intestine; as previously stated, the rear part of the intestine runs between them before it comes to the duodenum (Pl. III. Fig. VI. *i*; IX. *g*).

Each ovary is composed of a number of small cylindrical sacs or capsules, pointed at the end and lying in close juxtaposition to each other, without, however, being connected; the pointed end, and that only, is attached to a strong membrane inside the ovary.

The ovaries, when they answer this description, are not impregnated; when impregnated, the sacs or capsules increase in bulk, the end is no longer sharp but rounded, and they assume the shape of a pear; the posterior portion of the abdomen is distended, and becomes thicker, and the sacs increase in size and gradually protrude from the abdomen. Whether this protrusion is due to the bursting of the membrane of the abdomen, or whether the sacs protrude through openings for the purpose, has not yet been ascertained.

By this protrusion, these capsules are introduced into the gill-canal, or the gill-sac, but they are still connected with the interior membrane of the ovaries by the stalks or filaments at the sharp end; the other parts of the capsules are free, or lie close up on the interior surface of the membrane of the gills, but not attached to them; but few of these capsules penetrate into the gill-sac at one time (Pl. III. Fig. IX. *h*; X.).

* In the gills of *Anodonta* I have found the débris of the shells of parasites, and though in the gills of *Cyclas* (*Sphærium*) I have detected masses composed of fine sand or gravel, I have failed to discover the presence of any such débris.

These capsules contain the eggs, and the young are developed in them; each one contains but one egg or young one. As soon as the young has reached a certain size, the capsule bursts and the young is ejected into the gill-sac (Pl. III. Fig. IX. *i*).

It is in the gill-sac that the young grow, and when they have attained half a line in length they are ejected through the crescent-shaped lateral opening of the gill-sac and introduced into the cavity of the mantle; they then leave the parent and become free agents.

This genus brings forth young all summer.

We find in the gill-sac, at one and the same time, capsules and young, both large and small.

All these changes, I am led to believe, occupy but a very limited time.

Young taken out of the capsules measure about one quarter of a line; they are white, spherical, nearly flat, and the foot protrudes between the gaping valves, which are soft and somewhat membranaceous; they are very similar to the adult, but are somewhat flatter (Pl. III. Fig. XI.).

The young either lie free in the gill-sac or are suspended to its membranes, but they are not attached to it. No special motion is observed in the young while in the gill-sac; they grow rapidly, the shell becomes gradually of a pale yellowish color, the foot gradually withdraws within the valves, and when the shell attains one half a line in size the valves are closed; the shell then becomes harder, the color turns to a bright sulphurous, and its shape becomes more convex; when the young attain a size of one and one half lines, they leave the parent.

The young resemble the parent during all stages of their development; they undergo no metamorphosis.

The genus *Cyclas* (*Sphærium*) belongs to the class *Vivipara*. The eggs or the capsules containing them are not in a sufficient state of development to enable them to be hatched out if detached from the parent.

EXPLANATION OF THE PLATE.

All the figures are magnified, with the exception of Figs. 1 and 2.

FIG. I. *Cyclas* (*Sphærium*) with foot extended : *a*, shell ; *b*, foot ; all natural size.

FIG. II. Respiratory tubes extended : *a*, valves ; *b*, tubes ; all natural size.

FIG. III. *Cyclas* (*Sphærium*) seen from below : *a*, valves ; *b*, foot ; *c*, posterior transversal membrane ; *d*, interior pair of gills ; *e*, exterior pair of gills.

FIG. IV. Animal, valves removed in order to show the mantle : *a a b c*, the mantle : *a a*, dorsal part ; *b c*, inferior part open ; *d e*, the edges ; *f*, anterior adductor muscle ; *g*, posterior adductor ; *h*, crescent-shaped membrane in the anterior angle of the mantle opening ; *i*, membrane in the posterior angle, with its two apertures and *k* its transverse muscle ; *l l*, crescent-shaped lips formed by the edge of the mantle on each of its sides ; *m*, continuation of edges running up towards the dorsal region ; *n*, portion of the heart ; *o*, intestine running through the heart ; *p*, position and outline of the liver.

FIG. V. The transverse membrane extended : *a*, upper aperture, leading to the gill-canal ; *b*, inferior aperture, leading to the cavity of the mantle ; *c*, filaments encircling the apertures.

FIG. VI. Foot and abdomen : *a*, foot contracted ; *b*, ligaments holding it ; *c*, mouth ; *d*, tentacula of mouth ; *e*, liver ; *f*, first curve of the intestine ; *g*, portion of the intestine running through the ovaries ; *h*, rectum ; *i*, ovaries and the small cylinders composing them ; *α*, *β*, *ν*, nervous system ; *α*, anterior ganglion ; *ν*, posterior ganglion.

FIG. VII. Posterior and relative size of the gills : *a b*, exterior gill ; *c d*, interior gill ; *e*, gill-sac.

FIG. VIII. Interior gill and gill-sac : *a*, foot ; *b*, mouth ; *c*, tentacula of mouth ; *d e*, interior gill lifted up ; *f*, interior membrane of gill-sac ; *g*, the large crescent-shaped aperture ; *h*, posterior end of interior gill.

FIG. IX. Section showing the gill-sac : *a*, mantle ; *b*, exterior gill with its small gill-canal ; *d*, interior gill, with its gill-sac ; *e*, exterior membrane ; *f*, interior membrane ; *g*, ovaries ; *h*, capsules ; *i*, young.

FIG. X. A pair of pear-shaped capsules.

FIG. XI. Young at different stages, considerably magnified : *a*, valves ; *b*, protruding foot.

No. 6. — (Letter No. 2) *To* C. P. Patterson, *Superintendent Coast Survey, Washington, D. C., from* Alexander Agassiz, *on the Dredging Operations of the United States Coast Survey Steamer "Blake," during parts of March and April,* 1878, *with the Preliminary Report on the Mollusca of the Expedition, by* Wm. H. Dall, *Assist. U. S. Coast Survey.*

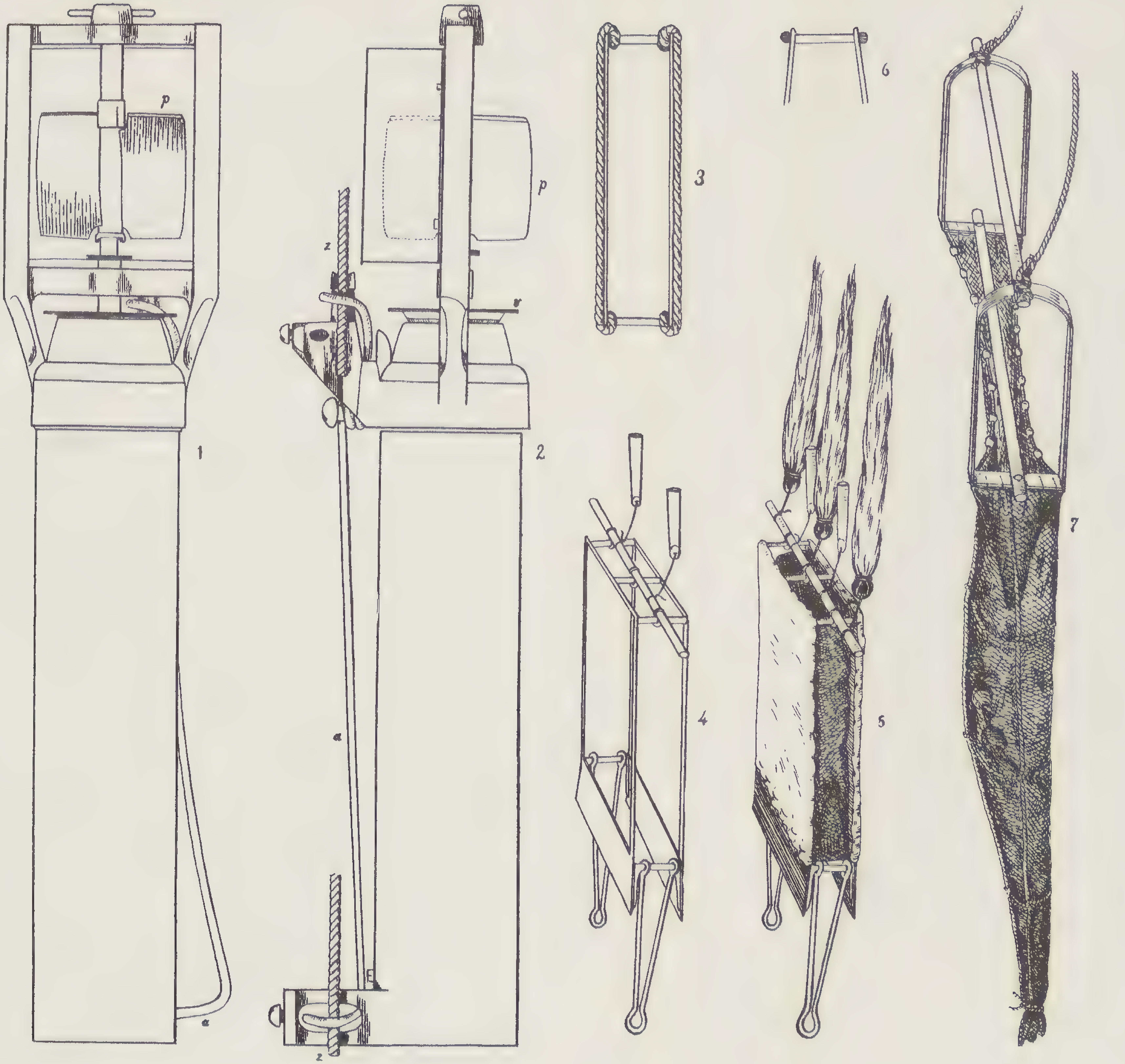
Since my last letter our operations have been confined to dredgings along a line to the northward of the Tortugas, running, in a general way, parallel to the 100-fathom curve of the western edge of the great Florida Bank. This line was extended northward to about the latitude of Tampa Bay, a distance of some 200 miles. A second line was then run from that point directly for the mouth of the Mississippi, a distance somewhat less than 200 miles. At New Orleans Mr. Garman and myself left the ship. It must have been a great relief to the officers of the "Blake," more particularly to the executive officer, Lieutenant Ackley, to be able to put the "Blake" again in an orderly condition. The work of dredging is not conducive to cleanliness, and during the whole time I was on board no routine was ever allowed to interfere with our work, Lieutenant Ackley himself always being the first to see that everything was in readiness for our dredging operations at all times. That the interest shown in the work by the other officers of the "Blake," Messrs. Sharrer, Jacobi, Moore, Sigsbee, and Dr. Nourse, did not flag after my departure, is amply testified by the collections made off Havana, containing some of the most valuable specimens of the expedition, all of which were forwarded to the Museum in an excellent state of preservation. The "Blake" subsequently returned to Key West to continue her regular work of sounding between the Tortugas, the coast of Cuba, and the Yucatan Bank. On the way to Key West, a few casts were made by Captain Sigsbee, on the Florida Bank, in lat. 26° 31′, long. 89° 03′, in a depth of 119 fathoms, at a point where a good idea of the fauna of the Florida Bank could be obtained. Before setting ashore the dredging apparatus, Captain Sigsbee ran over to Havana, hoping to be able to dredge a few specimens of Pentacrinus in one of the localities where we had, on a former occasion, found innumerable fragments of stems. He was most successful in thi[illegible]

tempt, and a short distance from the Morro light ($1\frac{1}{2}$ miles), at a depth varying from 242 to 42 fathoms, he brought up no less than twenty perfect specimens of Pentacrinus * of all sizes, beside a number of fragments which will be most useful for anatomical examination. The specimens obtained represent the two species thus far recognized, but I am inclined, from a cursory examination, to consider the P. Mülleri, with its distant cirri and more slender stem, merely as a younger stage of the P. Asterias, though the latter has a stouter stem and shorter intervals between the cirri. I shall send a number to Sir Wyville Thomson, who will examine our stalked Crinoids, Holopus and Pentacrinus,† at the same time with those of the "Challenger," and who will thus have ample materials for comparison and description. While on the way from Key West to the Tortugas we stopped at the Marquesas Islands, which form a circular ring of islands. Their formation has undoubtedly been identical with that of the great Alacran Reef, briefly described in my first letter, and, from the fact that no corals are now found living on their weather side, these islands must have assumed their present shape at the time when their weather side made a part of the outer reef in connection with the islands of Key West and the other keys, previous to the formation of the present growing reef, or while the latter existed only in the shape of a submerged reef several fathoms below the surface. I shall, on another occasion, give maps of the Alacran Reef as well as of the Marquesas, with the sections explaining their mode of formation. The weather during the greater part of our trip from the Tortugas to New Orleans was atrocious, as is usually the case during March in the Gulf of Mexico. We managed to do but little beyond ascertaining, in the most general way, the faunal characteristics of the lines run between Key West and New Orleans. Our materials were, however, ample to show that the deep-water fauna on the western slope of the great Florida Bank corresponds with that of similar depths ‡ on the eastern slope of the Bank of Yucatan, and that this deep-water fauna extends over the bottom of the Gulf of Mexico, until the line running from the 100-fathom line in latitude of Tampa Bay towards New Orleans strikes the Mississippi River slope. Here, owing to the presence of dark, rich mud, the fauna materially changed its character, and we obtained, off the Passes of

* See note from Captain Sigsbee.

† Rhizocrinus has now been so carefully studied by Sars, by Pourtalès, and by Ludwig, that it will form an excellent standard of comparison for the other genera.

‡ Noticed in a general way in my first letter.



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the Mississippi, in depths of from 118 to 600 fathoms, a number of interesting forms of Fishes, of Annelids, of Mollusks, of Ophiurans, and Sea-Urchins. The hauls in deeper water, off the Mississippi, yielded no specimens of importance. Throughout this last cruise we obtained, below 500 fathoms, the forms characteristic of deep water in all the deeper basins of the ocean, the more special or faunal species occurring at a lesser depth.

The new dredges improvised in Key West by Captain Sigsbee and Mr. Jacobi worked very satisfactorily, and were a great improvement on the old model, obviating completely the defects referred to in my last letter. The double trawl also worked admirably, obviating all fouling, and doing away with the frequent delays so annoying when the ordinary single-beam trawl is used in deep water.

The steel-wire rope continued to give excellent satisfaction, and we experienced fewer mishaps from causes connected with our rope than any other deep-sea dredging expedition. The uniform success attending our use of this rope during the past season enables me to recommend it to any future deep-sea dredging expedition as an economy of space, time, and money, for our rope occupied about one ninth of the space required by a hemp rope, and was, at the end of the cruise, as good as when we first left Key West.

There still remain many minor improvements, suggested by the use of the steel-wire rope, which would facilitate the working of the dredge or trawl, but not greatly increase their efficiency. Much still remains to be done, for instance in the way of a perfect accumulator. The accumulator devised by Captain Sigsbee consisted of a series of spiral steel springs capable of withstanding a strain of 4,000 pounds, these springs moved upon an iron rod; the accumulator was lashed vertically to the foremast, the play of the accumulator, some six feet, being transmitted to a large iron sheave over which the wire rope played. This iron sheave was suspended from a boom fastened by a swivel to the foot of the foremast, and projecting over the starboard bow far enough for the dredge or trawl to clear the side of the vessel. The steamer was invariably backed while dredging, our operations being all carried on at the bow. Of course, in a small vessel like the "Blake," a moderate sea soon made it not only difficult to dredge, but also endangered greatly all our dredging gear from the rapid rolling or pitching to which the accumulator could not respond promptly enough. It seems very doubtful if the accumulators used thus far are a great safeguard against accidents. While dredging, what is going on at the bottom can readily be ascer-

tained by keeping hold of the wire rope on deck, where the movements of the dredge are repeated by the vibrations of the steel rope so promptly that the moment it fouls or passes over rough bottom the speed of the vessel can at once be checked, or its direction altered, before the tension is great enough to affect the accumulators. It is only while hoisting the dredge that the accumulator is useful, and long before it works to its full power, the changes of form of the catenary of the wire rope, from an easy winding in of the dredge to the fouling of the same, will produce a greater or less strain, entirely unnoticed, on the accumulator, while winding up, if (as in our case) the strain is less than 2,000 pounds. The steel rope was hoisted by a small double-cylinder winding engine, with a surging drum of two feet in diameter, round which from six to ten turns were taken, according to the depth, and the rope then passed to the reel, where it was coiled as closely as practicable, the reel being turned by four men at the crank. A great improvement could be made in driving the reel from the winding engine at a greater speed than the drum of the engine.

In dredging, the dredge or trawl was invariably lowered independently of the winding engine from a reel built especially for our work. This reel, built of iron, consisted of a hollow axle two feet in diameter, four feet long, flanked by flanges extending eighteen inches above it, capable of winding 3,000 fathoms of $1\frac{1}{8}''$ steel-wire rope. The axle upon which the reel ran was supported upon bearings carried upon a strong iron frame securely bolted to the deck; the reel was checked by a band friction break, by which one man could readily control the velocity of the steel rope as it was unwound and accurately regulate the speed. The break was of sufficient strength to stop the dredge even at a depth of nearly 2,000 fathoms, and while dredging or trawling the break was securely held in place and the dredging carried on from it. To wind up, the wire rope was stopped and sufficient slack taken from the reel to make the necessary turns round the surging drum of the hoisting-engine. When this was done the reel was made taught, the stops unfastened, and the wire rope wound up by the winding engine until the dredge came in sight.

During the whole time the dredge or trawl was lowered or hoisted an accurate record was taken of the time spent in paying out or reeling in the rope, so that at any moment we knew the precise position of the dredge and the quantity of rope still out. The recorders were either Dr. Nourse or the Captain's clerk, Mr. Sigsbee.

The uniform success which attended all our hauls was undoubtedly

due not only to the improvements suggested in the apparatus by Captain Sigsbee, by Lieutenants Ackley and Sharrer, and by Messrs. Jacobi and Moore, but also to the great care taken by the officer of the deck in handling the "Blake" during the progress of a haul. With a vessel of the size of the "Blake," excellent judgment was necessary while working in a seaway, and that we incurred so few accidents is entirely due to the interest taken in the expedition by the officers, and the devices constantly suggested by them for overcoming the difficulties we encountered in this novel work.

The accompanying figures (Pl. I.) will explain the modifications introduced in the dredge and trawl.

A small map of the Gulf of Mexico, with the 100, 500, 1,000, 1,500, 1,800, and 2,000 fathom curve, has been prepared at the Coast Survey Office in order to give a general sketch of the Hydrography of the Gulf of Mexico. Only a small number of the soundings of the "Blake" are here introduced; they are selected from an immense number plotted during the last four years. The map speaks for itself, and I need only call attention in a general way to the principal features of the bottom. The most striking characteristics of the Gulf are the two great banks extending the one to the west of Florida peninsula and northward of the Florida Reef, the other northward of the peninsula of Yucatan, the 100-fathom line in both cases running in a general way parallel to the shore line and forming the edge of the steep slopes of the deeper parts of the central portion of the Gulf of Mexico. The rapidity with which the depth increases is very strikingly shown to the north of the Tortugas, and to the northward and westward of Alacran Reef, by the proximity of the 100 and 1,800 fathom curves, the eastern and southern edges of the central basin of the Gulf of Mexico having thus very steep sides, while the western and northern slopes are far more gradual. The north slope off Cuba is also quite abrupt, while the southern slope of the Florida Reef into the trough of the Gulf Stream is comparatively gentle. The soundings taken in 1878 have developed a remarkable extension of the southeast end of the Yucatan Bank within the 1000-fathom curve, in the direction of the Tortugas, with a depth of 500 to 700 fathoms for over one hundred miles. This will be shown in a more detailed map hereafter.

The greatest depth of the Yucatan Channel is somewhat more than 1,100 fathoms, so that the temperature of all the water which finds its way into the Gulf of Mexico is necessarily at its deepest point (2,119 fathoms) only the temperature of the bottom of the Straits of Yucatan

(1,127 fathoms), namely, $39\frac{1}{2}°$ Fahrenheit. The depth of the channel through which the water of the Gulf finds its outlet is very much less, — not more than 350 fathoms, — and the Straits of Bemini are not half the width of the Straits of Yucatan, while the temperature of the water at the bottom is much higher, with a far greater velocity at the surface than that of the current flowing into the Gulf of Mexico through the Straits of Yucatan.

Extract from Letter of Lieutenant Commander C. D. Sigsbee to A. Agassiz.

"On the first of April we put to sea again [from Havana]; we steamed about one and a half miles from the Morro (East), and at the third haul in 177 fathoms, from disintegrated coral rock bottom, up came six beautiful "sea lilies." Some of them came up on the tangles, some on the dredge. They were as brittle as glass. The heads soon curled over and showed a decided disposition to drop off. At a haul made soon after we got more, and being afraid to put so many of them in the tank together, I tried to delude the animals into the idea that they were in their native temperatures by putting them into ice-water. This worked well, although some of them became exasperated and shed some of their arms. They lived in the ice-water for two hours, until I transferred them to the tank. They moved their arms one at a time. Some of the lilies were white, some purple, some yellow; the latter was the color of the smaller and more delicate ones. All the sea lilies were obtained from the same place.

"At a point on the coast about one and a half miles to the eastward of Morro, there are the ruins of two detached houses one hundred yards apart and near the shore. Bring either of these houses to bear S. S. E. in 175 fathoms of water and dredge; sea lilies are bound to come."

In addition to the Pentacrini, Captain Sigsbee obtained from the same ground a most interesting addition to the species collected previously, especially among the Echini, Ophiurans, and Corals.

The following report of the Mollusca by Mr. W. H. Dall of the United States Coast Survey gives the results of a preliminary examination of the mollusks obtained during the cruise of the United States Coast Survey steamer "Blake" in the Gulf of Mexico and vicinity, with some others from the same region obtained formerly by Count Pourtalès and Dr. Stimpson in the United States Coast Survey steamer "Bibb": —

"The collection embraces material from three bathymetrical regions, which are more or less mixed throughout.

"I. The Pteropods and Heteropods from the surface of the sea, which are found mixed with most of the others from whencesoever derived.

"II. The shore fauna of the Gulf and Caribbean region, which in most re-

spects is well known, and extends from the margin of the sea and land to various depths according to the local temperature, but rarely in a living condition below 250 fathoms. Dead specimens belonging to this region, disgorged by birds or fishes, or washed by currents, are found mixed with the true deep-water fauna, and require the exercise of caution in assigning to the latter its true members. Thus, for instance, I find a specimen of *Pupa*, a land-shell, in dredgings from over 800 fathoms. The specimens from great depths off Morro Light, Havana, Cuba, are particularly mixed with littoral material.

"III. Lastly, we have the true deep-sea species, ranging from 1,920 fathoms to 200 fathoms, according to temperature, many of them coming much nearer the surface, when the temperature is cool enough, than has commonly been taken for granted.

"The material from regions I. and II. does not call for any especial remark at this time, but appears to contain some new forms, among them *Calliostoma Psyche*, a beautiful new species of Trochoid shell, recalling European rather than the West American forms of the genus, and remarkable as being the second species of the group known to inhabit the Gulf, which is peculiar for the paucity of *Trochi*. It does not seem to inhabit the shores, but is intermediate between the true deep-sea forms and those of the shore. I find among the members of the third bathymetrical zone several species known to be widely distributed in the deep-sea, such as *Pleuronectia lucida*, Jeffreys, and species of *Limopsis arca*, etc. figured, but not named, in Thomson's Atlantic Ocean volumes of the "Challenger" voyage. Besides these, the most interesting species are *Lyonsia bulla*, n. s., which may with further study prove to belong to the fossil genus *Gressleyia* of Agassiz ; *Euciroa elegantissima*, n. g. et sp., a beautiful pearly bivalve of the exquisite *Verticordia* group, which are mostly fossils ; *Pleurotoma* (*Candelabrum*) *cathedralis*, n. s., an exquisite gem collected by Pourtalès in the Gulf Stream expedition several years ago, but of which the original specimens were lost in the Chicago fire ; and *Dentalium perlongum*, n. s., the finest and most delicate of this abundant genus. The genera obtained from depths below 500 fathoms are *Limopsis*, *Arca*, *Aximea*, *Gouldia*, *Pleuronectia*, *Leda*, *Nucula*, *Lyonsia*, *Pleurotoma*, *Calliostoma*, *Trochus*, *Minolia*, and *Dentalium*, besides dead shells, which may or may not prove to belong with these associates.

"Of these, those from a greater depth than 1,000 fathoms are *Lyonsia bulla*, *Limopsis*, *Arca*, *Leda*, *Gouldia*, *Dentalium*, and a form of *Trochus* allied to *Minolia*. The *Lyonsia* cited came from the greatest depth of any, 1,920 fathoms.

"The general aspect of these collections is free from any trace of West American peculiarities. This was unexpected, remembering the *Haliotis* dredged off Florida by Pourtalès in his earlier work ; but that species was, according to my recollection, more allied to African than West-American forms of the same genus, and might indeed have proved identical with some West-African deep-water species, had its characters been put on record before it disappeared in the Chicago conflagration.

"I shall send preliminary diagnoses of the few forms specifically named

above, to secure priority for American work; but with regard to the species mentioned or indicated in the "Challenger" reports, but not described, I have left all such untouched, as belonging, by proper courtesy, to the English naturalists to make known."

A good part of the collections made in the "Blake" have already been sent to several naturalists for examination, and I hope to be able to publish, without too great delay, the preliminary Reports in addition to the one of Mr. Dall printed with this letter. The Fishes have been intrusted to Dr. F. Steindachner, Director of the Zoölogical Museum of Vienna; the Sponges, to Prof. Oscar Schmidt of Strasbourg; the Crustacea and Starfishes, to Prof. Alph. Milne-Edwards and to Prof. E. Perrier of the Jardin des Plantes of Paris; the Annelids, to Prof. Ernst Ehlers of Göttingen. The Crinoids, as I have stated, will be sent to Sir Wyville Thomson, the Ascidians to Prof. Lacaze Duthiers, the Foraminifera to Mr. H. B. Brady, and the Ostracoda to Mr. G. S. Brady, both of Newcastle. In this country the Corals and Holothurians will be worked up by Mr. Pourtalès, the Ophiurans by Mr. Lyman, the Hydroids by Mr. S. F. Clark of the John's Hopkins University, and I shall take the Sea-Urchins myself. No disposition has as yet been made of the Halcyonoids and Bryozoa. As the latter are not numerous, it is possible that the collection does not contain many novelties. They will be examined and compared with the collection formerly made by Mr. Pourtalès, and described by Professor Smitt, of Stockholm.

EXPLANATION OF PLATE I.

From sketches by Captain Sigsbee.

The annexed sketches of Captain Sigsbee's water-bottle, Pl. I, Figs. 1, 2, will interest those who have used the apparatus for obtaining water from great depth. The method of closing the valves is entirely different from that employed by other hydrographers. It seems far more accurate for deep water than the water-bottles used by the "Challenger," and by the Swedish or the German expeditions. The tests to which it has been submitted show that it closes in a depth of about ten to fifteen fathoms, that it then remains hermetically sealed, and that no amount of pitching or stopping can open the valves again, when once closed. For serial lines the water-bottles and thermometers were not sent down on the sounding line, but a stronger steel cord, three eighths of an inch in circumference, was used, to which the thermometers and bottles were attached. No attempt was made on our trip to make any chemical examination of the water from different depths. The small size of the vessel made a chemical laboratory out of the question, and it seems more natural for another expedition to establish a laboratory on shore at some point near deep water, and carry the bottles to the laboratory for analysis.

Fig. 1 gives a view of Captain Sigsbee's water-bottle, seen facing the frame of the propeller (*p*), by which the valves are closed. As long as the bottle sinks, the valves remain open. These are connected by a rigid rod, extending through the centre of the bottle. The moment it is hauled up the propeller is forced down on the shaft, until it presses with all its force upon the upper valves, and when this takes place it also slips out from its connection with the upper end of the shaft, so that, should the bottle be lowered again, the propeller could not rise and the valves be opened.

Fig. 2 shows the same bottle, at right angles to Fig. 1, with the mode of attaching it to the steel rope (*z*) by means of a spring (*a*). This is done in an instant, and the bottles firmly held in place by the double spring holding the rope at two points. A similar mode of attachment for the deep-sea thermometers would be a great saving of time when making a serial line of temperatures.

Fig. 3 shows the mouth of an ordinary dredge, with the rope stopped round it to prevent its digging into the mud, as first applied by Captain Sigsbee.

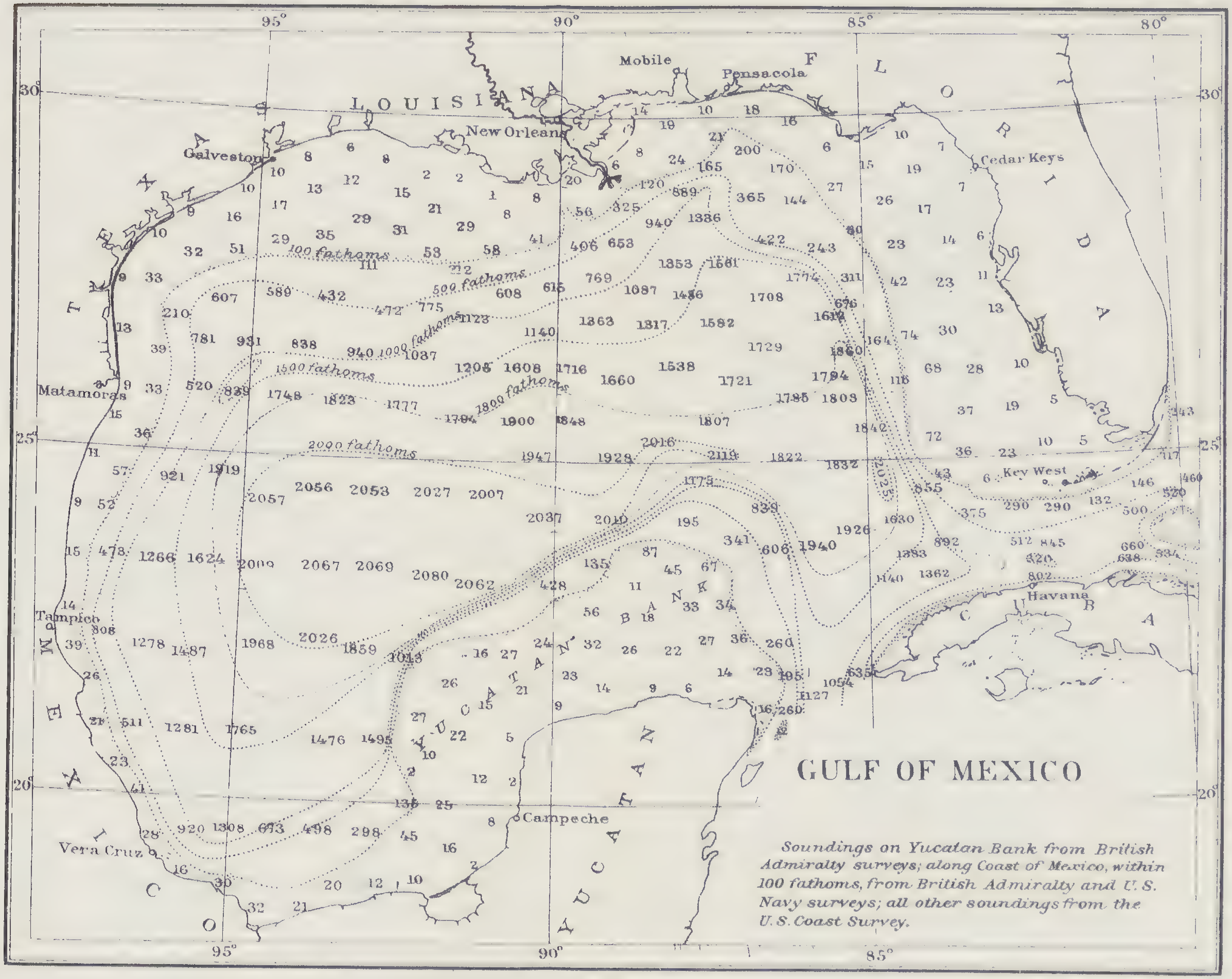
Fig. 4 gives a sketch of the iron frame of the flat dredge, with the mode of attaching the tangles, figured with its covering and appendages in Fig. 5.

Fig. 5. The dredge, as modified by Captain Sigsbee and Mr. Jacobi, in use on the "Blake." The end of the dredge-bag was, as in the trawl, securely tied and fastened to the frame, to prevent its reversing. A trap, as in an ordinary lobster pot, also prevented the washing out of many specimens when the dredge came to the surface. The opening of this dredge was 4 ft. by 12 inches.

Fig. 6. Section of Fig. 3.

Fig. 7. In a sketch of the double trawl (10 ft. beam) used on board the "Blake," the end of the trawl was securely tied so as to gain easy access to the specimens accumulated at the end of the trawl. A set of cork floats suspended in the middle of the trawl kept one side of the net well up from the bottom. The trawl had the usual trap. To the end of the trawl a common wooden detacher, similar to that of a deep-sea sounding machine, was fastened for detaching the shot with which it was usually weighted. At great depths weights were attached to the runners. The trawl was strengthened by ropes forming a large network to support it.

I hope, in my next letter, to be able to give detailed drawings of Captain Sigsbee's water-bottle and of his modifications of Sir William Thomson's sounding-machine.



GULF OF MEXICO
Soundings on Yucatan Bank from British Admiralty surveys; along Coast of Mexico, within 100 fathoms, from British Admiralty and U. S. Navy surveys; all other soundings from the U. S. Coast Survey.
LOUISIANA
FLORIDA
TEXAS
MEXICO
YUCATAN
YUCATAN BANK
CUBA
Mobile
Pensacola
New Orleans
Galveston
Cedar Keys
Key West
Havana
Matamoras
Tampico
Vera Cruz
Campeche
100 fathoms
500 fathoms
1000 fathoms
1500 fathoms
1800 fathoms
2000 fathoms
95°
90°
85°
80°
30°
25°
20°

No. 7. — *Ophiuridæ and Astrophytidæ of the Exploring Voyage of H. M. S. "Challenger," under* PROF. SIR WYVILLE THOMSON, F. R. S. By THEODORE LYMAN.

PART I.

(Published by permission of the LORDS COMMISSIONERS OF THE TREASURY.)

IN order that persons who are interested in Echinodermata may get early information, and to secure a just priority of discovery to the "Challenger" expedition, this Prodrome is printed.

It will be in two parts, and will contain descriptions of all new genera and species of Ophiuridæ and Astrophytidæ, with a simple outline figure of each. Part I. contains thirteen new genera and ninety-six new species, to wit: *Ophiocten*, 4 species; *Ophioglypha*, 35; *Ophiomastus*, 1; *Ophioplinthus*, 2; *Ophiomusium*, 12; *Ophiopyrgus*, 1; *Ophiernus*, 1; *Ophioceramis* (?), 2; *Ophiozona*, 4; *Ophiotrochus*, 1; *Ophiophyllum*, 1; *Ophiobyrsa*, 1; *Ophiochiton*, 1; *Ophiopyren*, 2; *Ophiacantha*, 16; *Ophiothamnus*, 1; *Ophiomitra*, 4; *Ophiocamax*, 1; *Ophiolebes*, 2; *Ophiosciasma*, 1; *Ophiogeron*, 1; *Ophioscolex*, 2.

Part II. will contain the remaining Ophiuridæ and the Astrophytidæ. All matters beyond those of description will be reserved for the more important work to be published by the British Government.

The following courses will give a general notion of the position of the dredging stations: —

Stations	1– 24,	Canaries to West Indies.
"	25– 58,	West Indies to Halifax.
"	59– 83,	Bermuda to Madeira.
"	84–128,	Madeira to Brazil.
"	129–140,	Brazil to Cape of Good Hope.
"	141–161,	Cape of Good Hope to South Australia by Antarctic Circle.
"	162–237,	Australia, by Philippines, to Japan.
"	238–260,	Japan to Sandwich Islands.
"	261–304,	Sandwich Islands to Patagonia.
"	305–321,	Patagonia to Buenos Ayres.
"	322–354,	Buenos Ayres to the Azores.

CAMBRIDGE, MASS., July 25, 1878.

OPHIOGLYPHA.

TABLE OF SPECIES HEREIN DESCRIBED.

NOTE. Following these descriptions will be found the species previously known and brought back by the "Challenger," namely, *O. Sarsii*, *O. acervata*, *O. sinensis*, *O. falcifera*, *O. hexactis*, *O. multispina*, *O. Lymani*.

Disk rather flat, and covered with imbricated scales. Under arm-plates small, widely separated; much wider than long beyond the second plate, and thereafter constantly diminishing in size. Arm-comb of more or less needle-like papillæ. Arm slightly flattened, with spines about as long as a joint. Tentacle-scales few beyond the second pair of pores. (*This is the typical form of the genus based on O. ciliata.*)		*O. ferruginea.*
Disk covered with smooth skin, through which the very small scales are scarcely or not at all visible. Arm-spines long, broad, and flat.		*O. flagellata.*
Disk-scales thin and smooth. Under arm-plates, within disk, large and touching each other. Arm-comb of sharp needle-like papillæ, with a well-marked under comb on the arm itself.		*O. palliata.*
Disk thin, with rather delicate scales, arms slender, with small spines. Papillæ of arm-comb sharp and cylindrical.	Four arm-spines; one long and high up, three short and low down. Radial shields touching without; disk-scales angular.	*O. lepida.*
	Three arm-spines; one long and high up, two short and low down. Radial shields separated; disk-scales small and curved.	*O. Ljungmani.*
	Four very short, peg-like arm-spines equally spaced.	*O. æqualis.*
	Three slender, equally spaced arm-spines. Mouth-shield trefoil, with a long lobe inward.	*O. imbecillis.*
Disk covered with smooth, moderately thick scales. Arm-spines small and short. Second under arm-plate about as long as broad, those farther out much broader than long. Papillæ of arm-comb close-set, flat, and with rounded ends.	Three very short, small, sharp arm-spines, low down. Mouth-shield wider than long, with a point within. Radial shields long and separated.	*O. irrorata.*
	Three very short, small, sharp arm-spines, low down. Mouth-shield as broad as long. Radial shields short, rounded, and separated by the fine scaling of the disk.	*O. orbiculata.*
	Three very short conical arm-spines, standing on middle of edge of plate. Disk-scales coarse and rather thick. Radial shields broader than long and joined.	*O. undulata.*
	Three very short, blunt, peg-like arm-spines, evenly spaced. Disk-scales few and large. Radial shields long and separated.	*O. costata.*
	Six short, blunt, peg-like, evenly spaced arm-spines. Arms narrow. Radial shields short and separated by one or two large rounded plates.	*O. albata.*
	Three slender pointed arm-spines, about two thirds as long as a joint. Disk-scales few and mostly large. Radial shields large and joined.	*O. jejuna.*
Disk-scales of moderate size, thick, and swollen. Very small, narrow side mouth-shields. Arm-spines short. Tentacle-scales numerous. Under arm-plates within disk about as broad as long, and separating the side arm-plates.	Three short, blunt, peg-like arm-spines evenly spaced. Papillæ of arm-comb short, close-set, and sharp.	*O. brevispina?* E. A. Sm.
	Four short, blunt, peg-like arm-spines, three together, low down, and one higher up. Papillæ of arm-comb short, close-set, and squarish.	*O. ambigua.*
Disk smooth and flat, with scales, radial shields, and mouth-shields all small. Arm-spines few and small. Mouth-papillæ and tentacle-scales similar, numerous, even, and close-set.	Three to five short, sharp arm-spines, about half as long as a joint.	*O. Loveni.*
	Five very minute, blunt arm-spines, which often are rubbed off or naturally wanting.	*O. fraterna.*
Disk high and arched. Arms short and thick. Each under arm-plate having a median, elongated, bead-like swelling. (*Type of O. Stuwitzii.*)		*O. elevata.*

- Disk high. Basal under arm-plates about as long as broad. Arms high and rounded, with very short spines. Side arm-plates not meeting below within disk. Side mouth-shields small, and at inner point of mouth-shield. Many tentacle-scales. (*Type of O. bullata.*)
  - Interbrachial space, below, covered almost entirely by the large mouth-shields and genital scales.
    - Three minute, evenly spaced arm-spines. Disk-scales above rounded and of various sizes, with large marginal plates. — *O. bullata* Wyv. Thom.
    - Three small tapering arm-spines. Disk covered above by a rosette of large angular primary plates, radial shields, and a few large interbrachial plates. — *O. convexa.*
  - Mouth-shield and genital scales large and conspicuous, but not covering the central margin of the interbrachial space.
    - Six minute arm-spines. First under arm-plate broader than long; those beyond longer than broad. Radial shields separated within by a cluster of large scales. — *O. sculptilis.*
    - Four or five minute arm-spines. Under arm-plates longer than broad. Radial shields separated at inner ends by a single scale. — *O. variabilis.*
    - Three or four minute, widely spaced arm-spines. Mouth-shield trefoil, with a pointed lobe inward. — *O. ornata.*
    - Three minute arm-spines, high up. Radial shields rounded, separated by one scale within. One large marginal plate with small scales about it. — *O. Lacazei.*
  - Three minute arm-spines. Disk covered by small irregular scales, small separated radial shields, and very large mouth-shields. — *O. lienosa.*
  - Two minute arm-spines. Mouth-shield trefoil. Under arm-plates axe-shape. Radial shields small and rounded. — *O. radiata.*
  - Four minute, blunt arm-spines. Disk-plates rough and lumpy, with rosette of large primaries. Under arm-plates pentagonal. — *O. undata.*
  - Eleven short, pointed, close-set arm-spines. Mouth-shields trefoil. Under arm-plates squarish. About eight tentacle-scales to each pore within the disk. — *O. lapidaria.*
- Basal under arm-plates, beyond the second, about as long as broad, squarish, and with water-pores between them. Arms high, with swollen upper arm-plates and very small spines. Upper disk covered in great part by a rosette of primary plates and by radial shields. — *O. solida.*
- Disk covered with much-swollen lumpy plates. Genital scales wide, thick, and in a single piece. Basal under arm-plates longer than wide. Papillæ of arm-comb short, flat, close-set, and with rounded ends. — *O. rugosa.*
- Disk-plates high and excessively swollen. Upper arm-plates rising in a high sharp ridge. Arm-spines minute, close-set, and like little blocks. — *O. ponderosa.*
- Interbrachial space below covered by only one or two plates besides the genital scales. Upper arm-plates rudimentary or wanting. Tentacle-pores of arm with only one rounded scale. — *O. minuta.*
- Disk thick, and covered with thin smooth scales. No arm-comb, nor papillæ along genital openings. Basal under arm-plates, beyond the second, short and wide. — *O. inermis.*
- Disk and arm-plates thick, swollen, and closely soldered. Mouth-papillæ and scales of mouth-tentacles thick, squarish, irregular, and crowded. Arm-spines minute, with tentacle-scales similar in form, and standing only on side arm-plate, inside the pore.
  - No true arm-comb.
    - Side mouth-shields large and ovoid. Radial shields and primary plates circular and similar. — *O. Deshayesi.*
    - Side mouth-shields small. Mouth-shield broader than long, with a peak inward. — *O. inornata.*
    - Disk-plates irregular and humpy. A group of papillæ near the arm, on margin of interbrachial space. — *O. confragosa.*
  - A small arm-comb. Side mouth-shields very narrow. — *O. intorta.*

Ophioglypha ferruginea sp. nov.

Plate III. Fig. 76.

Special Marks. — Disk rather flat and covered with imbricated scales. Under arm-plates small, widely separated; much wider than long beyond the second plate, and thereafter constantly diminishing in size. Arm-comb of papillæ more or less needle-like. Arm slightly flattened with spines about as long as a joint.

Description of an Individual (Station 162). — Diameter of disk 6.5 mm. Length of arm about 22 mm.; width of arm close to disk without spines 1.5 mm. Three or four short, pointed, widely separated papillæ on each side, and one or two, somewhat longer, at apex of jaw. Mouth-shields longer than wide, pentagonal, with an angle inward, lateral sides straight, outer edge rounding, length to breadth 1.7 : 1. Side mouth-shields nearly straight and narrow, slightly tapering inward, where they meet. First under arm-plate triangular, with an angle inward and outer edge curved; second one with lateral sides curved; those beyond are much broader than long, with curved outer edge and a small peak within. Side arm-plates slightly swollen, meeting broadly below, separated above by upper arm-plates, four-sided, with outer edge rounded, lateral sides straight, and inner side shorter than outer. Disk covered with closely joined, rounded scales of several sizes; radial shields short pear-seed shape, swollen, nearly meeting without, but separated their entire length by a wedge of one large and three or four smaller scales; space within the radial shields occupied by a central cluster of six primary plates, separated by minute scales, one or two larger plates in the brachial and interbrachial spaces, with other smaller ones irregularly disposed. Genital scales long and narrow; along their free edge is a line of very fine bead-like papillæ, becoming short regular spines as they pass to the upper surface to form the arm-comb, where the genital scales are much broader; interbrachial spaces below covered with rows of semicircular swollen plates, varying in size; at the margin is a large, much swollen plate, broader than long, on either side of which is a smaller oval one. Three long tapering arm-spines, the upper one being slightly longer than the others, and nearly as long as a joint. Tentacle-scales thin, and quite round, — on the large pores of the mouth-tentacles four or five on each side; on the second three on each side; third and fourth two on each side; those beyond have usually one large scale. Color in alcohol, below, white; above, mottled yellowish brown, and arms barred with the same.

O. ferruginea is of the strictly typical *Ophioglyphæ.* It is distinguished from *O. sinensis* by different mouth-shields and thicker disk-scales, and by wanting the water-pores between the basal under arm-plates.

Station 162, Bass Straits, 38 fathoms, 3 specimens. Port Jackson, 2–10 fathoms, 12 specimens. Station 161, 38 fathoms, 1 specimen. Station 188, 28 fathoms, 1 specimen.

Ophioglypha flagellata sp. nov.

Plate II. Figs. 49-51.

Special Marks. — Disk covered with smooth skin, through which the very small scales are scarcely or not at all visible. Arm-spines long, broad, and flat.

Description of an Individual (Station 232). — Diameter of disk 18 mm. Width of arm without spines 4 mm. Mouth-papillæ four or five on each side, small, tooth-like, separated, growing larger towards the apex of the jaw, where there is one large and club-shaped resembling the teeth above it. Mouth-shield small, short heart-shape, with projecting corners and angle inward; length to breadth 2.7 : 3. Side mouth-shields long and narrow, wider without than within, where they do not quite meet. First under arm-plate broader than long, triangular or rudely hexagonal, with angles much rounded; the plates beyond are much wider than long, bounded within by a blunt angle and without by a curve having a little peak at its apex. Side arm-plates rather thin, not meeting till some way beyond disk, widely separated above by upper arm-plates, which are hexagonal, much broader than long, very flat and thin, with outer and inner edges straight, and ill-marked lateral angles. Disk flat, covered with a thick skin, under which the thin small scales are scarcely, or not at all, distinguishable. Radial shields very small, rounded, and widely separated; length to breadth 1 : 1.5. Interbrachial spaces below covered by regular rows of very fine, minute scales, extending quite to the margin. Genital scales long and very narrow, almost concealed by the disk-scales; along the free edge is a row of very fine, delicately pointed papillæ, which grow longer as they pass upward to make a short arm-comb. Arm-spines longer than the joints, flat spatula-shape, arranged in a cluster of three just outside the tentacle-pores; of which those of the mouth-tentacles are very large, and have six or seven thin, flat scales on each side; the next three have three long thin flat scales on the inner side, and one or two very small slender ones on the outer side, beyond this three only, on the inner side. Color in alcohol, disk gray, upper arms yellow brown.

Station 232, 340 fathoms, 2 specimens.

Ophioglypha palliata sp. nov.

Plate IV. Figs. 98-100.

Special Marks. — Disk-scales thin and smooth. Under arm-plates, within disk, large and touching each other. Arm-comb of sharp needle-like papillæ, with a well-marked under comb on the arm itself.

Description of an Individual (Station 164 *a*). — Diameter of disk 10.5 mm. Width of arm close to disk 2.5 mm. Five or six small mouth-papillæ on each side, the two outermost being short and blunt, the next three or four sharply pointed, while the one at the apex of the jaw is large and rounded at the end. Mouth-shield pentagonal with a blunt angle inward, and outer

corners rounded. Length to breadth 2.5 : 2. Side mouth-shields long and narrow, meeting within ; broadest at their outer end, where they join the side arm-plates. First under arm-plates irregular, transverse oval ; the second similar, but larger ; those immediately beyond are transverse diamond-shape, with much rounded angles. Side arm-plates broad and thin, not meeting below till beyond the disk, widely separated above by the upper arm-plates, of which the first one is small and triangular, the second quadrangular, with the outer edge widest and curved, and inner edge straight. Upper surface of disk, which is smooth and even, covered with thin, fine, ill-defined curved scales ; the radial shields are longer than wide, with edge much rounded, separated their entire length by small scales. Under surface covered by rows of scales somewhat larger than the scales above. Genital scales wholly covered by the scaling, except above, where they support an arm-comb of sharp, slender papillæ ; their free edge below carries a row of small conical papillæ. Three tapering arm-spines, upper one longest, second and third about equal. Three or four small rounded tentacle-scales on each side of the mouth-tentacles, second and third pores having three on each side ; those just beyond with four short sharp scales on the inner side. Color in alcohol, gray.

Station 164 *a*, 400 – 1200 fathoms, 1 specimen.

Ophioglypha lepida sp. nov.

Plate III. Figs. 71 - 73.

Special Marks. — Four arm-spines ; one long and high up, three short and low down. Radial shields touching without ; disk-scales angular. Disk thin, with rather delicate scales. Arms slender.

Description of an Individual (Station 46). — Diameter of disk 9 mm. Width of arm close to disk 1.5 mm. Mouth-papillæ three to four on each side, short and square, with a larger pointed one at apex of jaw. Mouth-shield wide pentagonal, with an obtuse angle inward, outer edge slightly curved, and outer corners rounded ; length to breadth 1 : 1. Side mouth-shields long narrow, wider without, tapering inward where they meet. First under arm-plate broad triangular, those beyond pentagonal, with obtuse angle inward, lateral sides re-enteringly curved and outer edge slightly curved ; beyond the disk they gradually acquire the shape of a transverse oval, with a little peak without and within. Side arm-plates even, giving a tubular figure to the arm, meeting below, but separated above by the upper arm-plates, which are as long as broad, and in shape long hexagonal, with the three outer angles almost blended in a curve. Disk smooth, covered with small, delicate, irregular, ill-defined, closely soldered scales ; radial shields long pear-seed shape, overlapped along their edges by the surrounding scales, diverging inward and separated their entire length by a wedge of smaller and larger scales ; in centre of disk one large round primary plate, and another in each brachial space, lying close to inner ends of radial shields. Disk, below, covered with very fine irregularly shaped

scales. Genital openings edged with fine, closely set papillæ, growing larger as they pass upwards along the outer edge of genital scale, which is long, narrow within, broad without, and divided in several pieces. Three short and blunt arm-spines, situated low on the side arm-plates, close to the tentacle-pores, and one long tapering spine, just below the junction of the upper arm-plate. Tentacle-scales short and rounded; to each mouth-tentacle seven on the interbrachial side, and three longer and tapering on the brachial edge; beyond there are at first five on the interbrachial and four on the brachial edge, after which they diminish rapidly in number and size. Color in alcohol, gray.

O. lepida and its kindred species form an intermediate type between the shallower, like *O. albida*, and the deep-sea, of which *O. bullata* is the extreme.

Station 46, 1350 fathoms, 5 specimens. Off Bermuda, 750 fathoms, 2 specimens. Station 76, 900 fathoms, 4 specimens. Station 45, 1240 fathoms, 1 specimen. Station 343, 420 fathoms, 1 specimen.

Ophioglypha Ljungmani sp. nov.

Plate III. Fig. 77.

Special Marks. — Three arm-spines; one long and high up, two short and low down. Radial shields separated; disk-scales small and curved. Disk thin, with rather delicate scales. Arms slender.

Description of an Individual (Station 122). — Diameter of disk 8.5 mm. Length of arm about 45 mm.; width of arm without spines close to disk 2 mm. Four or five short flat mouth-papillæ on each side, and one or two longer pointed papillæ at apex of jaw. Mouth-shield rounded triangular, or inclining to rounded pentagonal, with an angle inward, longer than broad, outer edge curved. Side mouth-shields very narrow, wider without, tapering within, where they nearly or quite meet. First under arm-plate broad triangular, with lateral corners truncated and outer edge curved; second, third, and fourth plates widely pentagonal, with an angle inward; beyond these they are small, broader than long, with an obtuse angle inward and a curved outer edge. Side arm-plates slightly projecting at their outer edge, meeting broadly below beyond the disk; separated above by the upper arm-plates, which are hexagonal, with lateral sides straight and two outer angles nearly blended in a curve. Disk smooth, covered with small irregular plates, but little swollen. Radial shields pear-seed shape, somewhat overlapped by adjoining scales, just touching without, diverging within, where they are separated by two or three small plates. The rest of the upper disk is occupied by numerous scales, among, and separated by which, appears a central cluster of primary plates; in the interbrachial spaces are usually one or more larger plates near the margin of the disk. Genital scales very broad above and without, where they carry an arm-comb of fine spines, but buried by disk-scales below near the mouth-shield; along their lower free edge is a row of minute tooth-like papillæ, between the genital plates and outside the mouth-shield. Interbrachial space

below covered by irregular overlapping scales. Three slender arm-spines, the longest one nearly as long as a joint, and situated near the junction of the side arm-plate with the upper, and two others similar but shorter near the junction of the side with the under arm-plate. Tentacle-scales small, short, pointed, four or five on each side of mouth-tentacle pore, whence they diminish in number, till just beyond the disk, where there are two on the inner side of each pore. Color in alcohol, gray.

Station 122, 350 fathoms, 12 specimens.

Ophioglypha æqualis sp. nov.

Plate III. Figs. 74, 75.

Special Marks. — Four very short, peg-like arm-spines, equally spaced. Disk thin, with rather delicate scales. Arms slender.

Description of an Individual (Station 218). — Diameter of disk 10 mm. Width of arm close to disk without spines 1.7 mm. Four or five short, square, separated mouth-papillæ on each side, with one much larger and pointed at apex of jaw. Mouth-shields broader than long, with outer edge curved, a blunt angle inward and a slight notch in the lateral sides; length to breadth 1.3 : 2. Side mouth-shields short and narrow, meeting within. First under arm-plate broad triangular, with outer edge curved and a blunt angle inward; second plate broader without than within, pentagonal, with an angle inward, outer edge slightly curved, and lateral sides re-enteringly curved; the rest are broader than long, rapidly becoming smaller in size beyond the disk, where they acquire the shape of a transverse oval, with a little peak within and a curve without. Side arm-plates even and of a tubular figure, slightly projecting at their outer edge, meeting widely below, separated above at the basal joints by the upper arm-plates, of which the first and second form a wedge with a curved outer edge, filling the notch formed by the arm-combs, and bearing on their lateral sides a row of minute, sharp papillæ; the rest are long, triangular, with the outer edge curved, and a sharp angle inward, which on the second and third plate is truncated. Disk flat and delicate, covered with very thin, small, closely overlapping scales; in the centre is a circular primary plate, surrounded by fine irregular scales, then a circle of five primary plates, one in each brachial space, and separating the inner ends of the radial shields, which are long pear-seed shape, and separated the rest of their length by small scales; in the interbrachial space there is a row of larger rounded plates, of which the outer one is marginal. Interbrachial spaces below covered with thin overlapping scales. Genital scales long and very narrow where next the mouth-shield, but gradually growing wider above the arm, where they make a long arm-comb carrying delicate spine-like papillæ; on the free edge of the genital scale below there is a row of very short, minute, rounded papillæ. Four or five minute, blunt arm-spines, equally spaced along the edge of the side arm-plate. The pores of the mouth-tentacles and the two pairs beyond

are long and large, and have from four to six small tentacle-scales on each side. Those a little beyond the disk have only one scale on the inner side and none on the outer. Color in alcohol, white.

Station 218, 1070 fathoms, 6 specimens.

Ophioglypha imbecilis sp. nov.

Plate III. Figs. 63, 64.

Special Marks. — Three slender, equally spaced arm-spines. Mouth-shield trefoil, with a long lobe inward. Disk thin, with rather delicate scales. Arms slender.

Description of an Individual (Station 232). — Diameter of disk 6.5 mm. Length of arm 20 mm. Width of arm near disk 1 mm. Mouth-papillæ four or five on each side, square, short, and closely set, with a pointed one at apex of jaw. Mouth-shields trefoil-shaped, with a lobe inward; length to breadth 1.5 : 1.5. Side mouth-shields curved, long, and narrow, of nearly even width, and meeting within. First arm-plate triangular, with angle inward, and outer side curved; second plate, which is largest of all, axe-shaped, with lateral sides re-enteringly curved; the rest are triangular, with outer side curved, and diminish constantly in size. Side arm-plates straight and rather delicate, meeting broadly above and below, beyond the second upper arm-plate. Upper arm-plates triangular, with acute angle inward, and outer edge curved. Upper surface of disk covered with irregular, rather thin plates. Radial shields longer than broad; outer edges curved, meeting broadly without, diverging inward, where they are separated by a smaller and larger plate. On the interbrachial margin of the disk is a large oval plate, broader than long, connecting the radial shields; in the centre a circular primary plate, surrounded by numerous others, irregularly shaped. Genital scales long and broad, bearing three or four papillæ near their outer end. Outside the mouth-shield and between the genital scales are two large semicircular plates, whose outer edges reach the margin of the disk. Three arm-spines, tapering, very delicate, situated half-way up on the side arm-plate, near base of arm; they are about half as long as a joint. Tentacle-scales minute and semicircular, two on either side of first two pores; at the third, two on the outer and one on the inner side; for the rest only one. Color in alcohol, gray.

Station 232, off Enosima, 340 fathoms, 5 specimens.

Ophioglypha irrorata sp. nov.

Plate IV. Figs. 106-108.

Special Marks. — Three very short, small, sharp arm-spines, low down. Mouth-shield wider than long, with a point within. Radial shields long and separated. Papillæ of arm-comb close-set, flat, and with rounded ends.

Description of an Individual (Station 143). — Diameter of disk 8.5 mm.

Width of arm close to disk, without spines, 1.7 mm. Six square, close-set mouth-papillæ on each side, and one large diamond-shaped at apex of jaw. Mouth-shield much broader than long, with outer edge much rounded and an obtuse angle inward; length to breadth 1.7 : 2. Side mouth-shields long and narrow, just meeting within and with a swelling at the outer end. First under arm-plate triangular, transverse oval, or wide rounded hexagonal; second plate pentagonal, with inner angle truncated, outer edge rounded and wider than inner one, lateral sides re-enteringly curved; beyond this they are rounded triangular, with a broad curve without, and a peak inward. Side arm-plates wide, flat, even; meeting broadly below, beyond third plate separated above by the upper arm-plates, which are four-sided, with inner side shorter than outer, which is curved. Disk flat and thin, covered with fine, closely overlapping scales; there are six large round primary plates, one in the centre and one to each brachial space, widely separated by the disk-scales; on the surface of the disk are a few scattered, very minute spines. Radial shields irregular rhomboidal, broad without and with a blunt angle inward, separated their entire length by a wedge of larger and smaller disk-scales; length to breadth 2 : 1. Interbrachial surface on the under side covered with the same fine overlapping scales as above. Genital scales small, narrow within, widening a little without as they appear above the disk. Along their free edge, which extends from outer edge of mouth-shield to margin of disk, there is a close row of minute, squarish, tooth-like papillæ, which become short and rounded on the arm-comb. Three small pointed arm-spines, situated low on the edge of the side arm-plate close to tentacle-scales. On the pores of the mouth-tentacles five large rounded scales similar to mouth-papillæ, on either side; on the second set six on the interbrachial side and four on the brachial; immediately beyond the disk there are only one or two on the inner and none on the outer side. Color in alcohol, white.

Station 143, 1900 fathoms, 1 specimen. Station 164, (young of this species ?) 410 fathoms, 6 specimens.

Ophioglypha orbiculata sp. nov.

Plate IV. Figs. 103-105.

Special Marks. — Three very short, small, sharp arm-spines, low down. Mouth-shield as broad as long. Radial shields short, rounded, and separated by the fine scaling of the disk. Papillæ of arm-comb close-set, flat, and with rounded ends.

Description of an Individual (Station 237). — Diameter of disk 15.5 mm. Width of arm close to disk 2.7 mm. Six or seven mouth-papillæ on each side, small, irregular, and tooth-like, with three longer and more pointed at apex of jaw. Mouth-shield broader than long, five-sided, having a broad angle within, with outer lateral corners rounded; length to breadth 2.5 : 2.3. Side mouth-shields, following inner angle of mouth-shield, narrow, pointed without, and

broader within, where they meet. First under arm-plate transverse oval, broader than long, often with lateral ends pointed; second arm-plate four-sided, with corners much rounded; the next three are pentagonal, with an angle inward, and outer edge curved; beyond these the lateral sides become shorter, so that soon the form changes to very wide triangular, with a broad curved outer edge, and an obtuse angle inward. Side arm-plates broad, little swollen, meeting below beyond the disk, separated above by upper arm-plates, of which the first is oval, with pointed lateral ends; those beyond four-sided, broader without than within, outer side curved, lateral sides nearly straight. Disk flat, smooth, and very thin; upper surface covered with small, irregular, closely overlapping scales, with a row of larger scales along the margin. Radial shields broad triangular, with edges rounded, separated widely by a group of disk-scales; length to breadth 2.3 : 2. On the under surface the scales are more uniform, and are arranged in irregular transverse rows, four to six in each row. The genital plate, except at its outer end, appears only as a narrow line, bearing a close row of short, square papillæ, which become larger and more rounded where they form the arm-comb. Three short, bluntly pointed arm-spines, situated near the junction of the side with the under arm-plate. Seven square, close-set scales on each side of mouth-tentacle pores; the next two pairs have four on each side; the next one usually three on the inside and two on the other; beyond the disk only one on the inner side. Color in alcohol, white.

Station 237, 1875 fathoms, 10 specimens.

Ophioglypha undulata sp. nov.

Plate III. Figs. 61, 62.

Special Marks. — Three very short, conical arm-spines, standing on middle of edge of plate. Disk-scales coarse and rather thick. Radial shields broader than long, and joined. Papillæ of arm-comb close-set, flat, and with rounded ends.

Description of an Individual (Station 224). — Diameter of disk 12 mm. Width of arm close to disk, without spines, 2.3 mm. Mouth-papillæ four on each side, short and square and closely set, the outer one widest; at angle of the jaw usually a cluster of three conical papillæ. Mouth-shield rounded triangular, much broader than long, with an obtuse angle within, and outer side slightly curved; length to breadth 2.3 : 2.3. Side mouth-shields nearly straight, rather long, and meeting fully within. First under arm-plate oval or rounded hexagonal, and wider than long; the next longer than any other, axe-shaped, with long lateral sides re-enteringly curved and outer side curved; those beyond grow rapidly shorter, and beyond the fourth are separated by the side arm-plates, which are regular and scarcely swollen, and meet above and below beyond the fourth upper arm-plate. First upper arm-plate wide, semicircular; the rest diamond-shaped, with inner angle truncated and the outer more or less

curved. Disk high, covered with rather thin, irregular, curved plates, among which may be seen a central five-sided primary, and a large wide plate on the margin of the disk, much broader than long. Radial shields rudely semicircular, and meeting only at their outer points, diverging inward, where they are separated by a small triangular plate. The interbrachial space on the under surface is covered by the rather long and narrow genital scales, which are broken in two, and bear no papillæ, and by two large irregularly curved plates, between which and the mouth-shield are from one to three little scales. Arm-spines three, short, very small, conical, situated half-way on the outer edge of the side arm-plate. Tentacle-pores, except the first pair, small and narrow. The first bears about three scales on each side ; the second, the same ; the third, two ; and the fourth, one minute scale on the outer and two on the inner side. Color in alcohol, disk pale gray, arms white

Station 224, 1850 fathoms, 1 specimen.

Ophioglypha costata sp. nov.

Plate IV. Figs. 92-94.

Special Marks. — Three very short, blunt, peg-like arm-spines, evenly spaced. Disk-scales few and large. Radial shields long and separated. Papillæ of arm-comb close-set, flat, and with rounded ends.

Description of an Individual (Station 142). — Diameter of disk 6.5 mm. Width of arm close to disk 1.3 mm. Mouth-papillæ five or six on each side, short, square, close-set, with one larger, diamond-shaped, at apex of jaw. Mouth-shield five-sided, with outer edge curved, lateral sides nearly straight, and an obtuse angle within ; length to breadth 1 : 1. Side mouth-shields rather short, lying along inner angle of mouth-shield, meeting within. First under arm-plate broad triangular, with an angle within and curved outer edge ; the rest are pentagonal, broader than long, with an obtuse angle within, short lateral sides, and a long curved outer edge. Side arm-plates a little swollen and constricted at their inner end, meeting below ; separated above for the first three joints by the upper arm-plates, of which the first is transverse oval ; the second four-sided, with a curved outer edge much wider than the inner ; and the rest triangular, with an angle within and curved outer edge. Disk rather flat, and covered by angular plates and a few small rounded scales, closely overlapping ; in centre a five-sided rosette of primary plates, which are rounded and partly separated by minute scales ; in the interbrachial spaces a single or double row of larger and smaller plates. Radial shields rhomboidal, with the angles slightly rounded ; length to breadth 2 : 1 ; separated without by a large diamond-shaped plate, with its outer and inner angles truncated. The lower interbrachial spaces have a large marginal plate and four or five smaller ones ; genital scales wide, bearing on their free edge a close-set row of fine papillæ, which grow somewhat larger and more rounded above to form the arm-comb. Three arm-spines, minute, blunt, and equally spaced. Tentacle-scales short and squarish, five on one side and three on the other of the pores

of the mouth-tentacles ; the second pores have three on each side, and those beyond not so many. Beyond the disk there are no tentacle-scales, and the tentacles are very minute. Color in alcohol, white.

This species is pretty near *O. Lymani*, but is readily distinguished by its flat upper arm-plates, those of *O. Lymani* being high and more or less ridged.

Station 141, 98 fathoms, 6 specimens (young). Station 142, 150 fathoms, 6 specimens.

Ophioglypha albata sp. nov.

Plate IV. Figs. 95-97.

Special Marks. — Six short, blunt, peg-like, evenly spaced arm-spines. Arms narrow. Radial shields short, and separated by one or two large rounded plates. Papillæ of arm-comb close-set, flat, and with rounded ends.

Description of an Individual (Station 236). — Diameter of disk 10 mm. Length of arm about 40 mm. Width of arm close to disk 2 mm. Three short, crowded mouth-papillæ on each side, with one (or sometimes three) conical at apex of jaw. Mouth-shield pentagonal, having a blunt angle within and outer corners curved ; length to breadth 1.5 : 1.3. Side mouth-shields narrow, meeting within ; running along inner angle of mouth-shield, and passing beyond to join first under arm-plate, where they are widest. First under arm-plate irregular transverse oval ; second plate short, bell-shaped, wider without than within ; those immediately beyond are five-sided, wider without than within, with outer edge curved, a blunt angle inward, and inner lateral sides a little re-enteringly curved ; about half-way out on the arm they become nearly triangular, broader than long, with outer angles much curved. Side arm-plates broad, but little swollen, not meeting below within the disk, widely separated above by the upper arm-plates, of which the second and third are hexagonal, while those beyond are lengthened, their two outer angles blended in a curve, and the inner side very short. Disk smooth and slightly arched, covered with thin, rounded or angular, closely soldered scales, the six primaries being a little larger and separated by one or two rows of scales ; there is a transverse row of three large angular plates extending along the margin and connecting the radial shields, which are longer than wide, angular, widely separated by two or three large scales ; their outer points may or may not meet : under surface covered by rows of thin, ill-defined plates, similar to those above. Genital scales hidden by the disk-scales ; along their free edge is a close row of short, bead-like papillæ : they become larger and more rounded where they pass upward to make the arm-comb, which is attached to the radial shield. Six short, blunt, conical arm-spines, arranged along the entire margin of the side arm-plate. The pores of the mouth-tentacles are large, and have four short close-set scales on either side ; the two next have three small rounded scales on the inner side ; those beyond have two. There are also minute and not easily seen scales on the outer side of the second and third pores. Color in alcohol, white.

Station 236, 775 fathoms, 1 specimen.

Ophioglypha jejuna sp. nov.

Plate II. Figs. 55, 56.

Special Marks. — Three slender, pointed arm-spines, about two thirds as long as a joint. Disk-scales few and mostly large. Radial shields large and joined. Papillæ of arm-comb close-set, flat, and with rounded ends.

Description of an Individual (off Tristan d'Acunha). — Diameter of disk 5 mm. Width of arm 1 mm. Mouth-papillæ small, tooth-like, and close-set, five on each side, with long pointed one at apex of jaw; those near the outer angle of the jaw broader than long, growing longer as they near the inner angle. Mouth-shield pentagonal, length and breadth about equal, the outer and lateral sides curved, with corners rounded and a very blunt angle inward. Side mouth-shields long and narrow, curved, with club-like outer ends; narrower within, where they barely meet. First under arm-plate large triangular, with outer end curved and a blunt angle inward; second and third plate five-sided, with lateral sides nearly straight and outer corners rounded. Side arm-plates broad, slightly swollen, meeting below, but separated above on first two joints by upper arm-plates, which are wedge-shaped, with outer side curved and a long sharp angle within; those beyond are similar, but separated by side arm-plate. Disk flat and smooth, covered with thin rounded plates or scales; in centre of upper surface is a close rosette of five round primary plates, with three small ones in their midst; in each interbrachial space are two large rounded plates, of which the outer is marginal, with some small scales on either side. Radial shields rudely triangular, with an angle inward, joined, except at their inner points, where they are separated by a small wedge-scale; length to breadth 1 : .7. Genital scales long and narrow, wider without than within, bearing on their free edge a row of fine, close-set, tooth-like papillæ, extending to base of upper arm-plate, where they become scale-like and form the arm-comb. Interbrachial spaces below covered by half a dozen rounded plates or scales of several sizes, whereof the largest lies on the margin. Arm-spines three, delicately tapering, about two thirds as long as a joint, equally spaced on the side arm-plate. Scales of mouth-tentacles small and tooth-like; four on the brachial side and five on the other; on the next three pores are only two pointed, spine-like scales. Color in alcohol, brown.

Station 135, off Tristan d'Acunha, 500 fathoms, 2 specimens. Station 164 *a*, 410 fathoms, 1 specimen.

Ophioglypha brevispina (?) E. A. Smith.

Ophioglypha brevispina E. A. Smith, Ann. and Mag. N. H., XVII. p. 112, Feb., 1876. Transit of Venus Expedition, p. 11, Pl. XVII., Figs. 5, *a – c*.

Plate II. Figs. 44 - 46.

Special Marks. — Three short, blunt, peg-like arm-spines, evenly spaced. Papillæ of arm-comb short, close-set, and sharp. Disk-scales of moderate size, thick and swollen. Very small, narrow side mouth-shields.

Description of an Individual (Royal Sound). — Diameter of disk 11 mm. Length of arm 45 mm. Width of arm 2.5 mm. Mouth-papillæ short, blunt, close-set, four or five on each side, and two longer at apex of jaw. Mouth-shield pentagonal, with a blunt angle inward, outer edge curved, lateral sides notched; length to breadth, 2.3 : 2. Side mouth-shields extending along inner angle of mouth-shield, narrow, of about even width, meeting within. First under arm-plate very large, broader than long, transverse oval in shape; next three plates wider without than within, their sides straight, except the outer, which is curved; the rest are triangular, with outer edge curved, and an angle within. Side arm-plates short, slightly swollen, just meeting below, beyond the disk; widely separated above by the upper arm-plates, which are large, arched, much broader than long, wider without than within, with outer side curved and inner side re-enteringly curved. The upper surface of disk has numerous rounded, much swollen plates, closely soldered together, with a cluster of six primaries in the centre separated by one or two rows of smaller plates; outside this cluster in each interbrachial space is another large rounded plate. Radial shields longer than broad, much rounded, the inner end slightly smaller than outer, their inner ends widely separated by a large rounded triangular plate within and smaller scales without; length to breadth 2 : 1.5. Interbrachial space below evenly covered by small thick scales. The genital scale is nearly or quite covered, except at its outer portion, whose free edge carries a row of very fine saw-like papillæ, which become a little longer above, where they make the arm-comb. Three small blunt arm-spines, equally spaced, and standing low on the outer edge of side arm-plate. The pores of the mouth-tentacles have four or five close-set, small, tooth-like scales on each side; the second and third set have four or five on the interbrachial side, and three on the brachial; beyond this they diminish till a short distance beyond the disk, where there is on the inner side a small scale, similar to and continuous with the arm-spines, and on the outer side a little ridge. Color in alcohol, light gray.

Mr. Smith, who kindly compared a "Challenger" specimen with his originals, reports that the latter are smaller, and differ from the former in having disk-scales coarser, radial shields that converge and touch each other, upper arm-plates narrower inward, etc. As these differences may depend on age, I have retained the name with a query.

Royal Sound, Kerguelen Islands, 25 – 28 fathoms, 12 + specimens. Balfour Bay, Kerguelen Islands, 20 – 60 fathoms, 2 specimens. Off Christmas Harbor, Kerguelen Islands, 120 fathoms, 1 specimen.

Ophioglypha ambigua sp. nov.

Plate II. Figs. 47, 48.

Special Marks. — Four short, blunt, peg-like arm-spines, three together, low down, and one higher up. Papillæ of arm-comb short, close-set, and squarish. Disk-scales of moderate size, thick and swollen. Very small, narrow side mouth-shields.

Description of an Individual (Royal Sound). — Diameter of disk 13.5 mm. Width of the arm close to disk 2.5 mm. Mouth-papillæ short, blunt, tooth-like, and close-set, five on each side, similar to and continuous with the tentacle-scales of the mouth-tentacles, with a larger, longer, and pointed one at angle of jaw. Mouth-shield pentagonal, with outer edge rounded, lateral sides notched, and a blunt angle inward; length to breadth 3 : 2. Side mouth-shields short, just meeting within and slightly wider at their outer end. First under arm-plate large, rudely diamond-shaped, with outer and inner angles rounded; the next two or three plates four-sided, wider without than within, with outer side curved and re-entering curves on lateral sides; further out they become pentagonal, much broader than long, with an angle inward. Side arm-plates short and thick, not meeting below till some distance from the disk; widely separated above by upper arm-plates, much broader than long, arched, wider without than within, outer edge curved, inner edge re-enteringly curved. Disk thick and angular, covered with thick, closely soldered, irregularly shaped plates, among which the primaries may be distinguished, but not very clearly. Radial shields small, irregularly triangular, with angles rounded, widely separated by one large and two or three small scales; length to breadth 2 : 1.5. Genital plates short, beginning opposite fourth under arm-plate and widening rapidly outward; along the free edge is a row of fine, short, square, close-set papillæ, extending as an unbroken line upward to form the arm-comb. Four short, blunt, and tooth-like arm-spines, three in a cluster, close to edge of tentacle-pores, and one a little separated above; farther out the four make a continuous group. Tentacle-pores large; those of the mouth-tentacles have five short, rounded scales on the interbrachial side and four on the other; the next pair, six on one side and five on the other; thence they diminish till some distance beyond the disk, where there is but one tentacle-scale, similar to and continuous with the arm-spines. Color in alcohol, light gray.

Royal Sound, Kerguelen Islands, 25 – 28 fathoms, 12 + specimens. Off Christmas Harbor, Kerguelen Islands, 120 fathoms, 12 + specimens.

Ophioglypha Loveni sp. nov.

Plate IV. Figs. 109 – 111.

Special Marks. — Three to five short, sharp arm-spines, about half as long as a joint. Disk smooth and flat, with scales, radial shields, and mouth-shields all small.

Description of an Individual (Station 157). — Diameter of disk 21 mm. Width of arm close to disk 3.7 mm. Six or seven small rounded mouth-papillæ on each side, the outer three being closely soldered together; at apex of jaw a clump of three larger papillæ. Mouth-shields triangular, with an obtuse angle within, and the outer edge much rounded; length to breadth 3.5 : 4. Side mouth-shields following inner angle of the mouth-shield, rather narrow without, where the mouth-tentacle pores encroach, wider within, where

they scarcely meet. First under arm-plate broad triangular, or broad rounded hexagonal, with outer edge much curved, and a very blunt angle inward; second plate nearly square, with rounded corners; the next two rudely semicircular, with outer edge straight, or broad much rounded pentagonal, with an ill-marked angle inward; the rest are transverse oval, with a peak inward. Side arm-plates wide, a little swollen, meeting below beyond the disk, separated above by the upper arm-plates, which are much broader than long, with outer edge broken in three angles or curved, and the lateral sides forming an angle. Disk arched, but not thick, covered above and below with small, thin, closely soldered scales, the six primaries being small, circular, widely separated plates. Radial shields much longer than wide, with a sharp angle inward, separated by a wedge of disk-scales; length to breadth 4.5 : 2. Genital scales very narrow, covered by fine scaling, bearing on their free edge a close row of very fine, square papillæ, which increase a little in size as they appear above to form the arm-comb. Three tapering arm-spines, about half as long as a joint; the upper one the longest. Larger specimens have five or more spines. On the mouth-tentacle pores there are seven or eight close-set, tooth-like scales on either side; the next two pairs have six or seven on each side, just beyond the disk; there are four scales on the inner side, and the same number of smaller ones on the outer. Color in alcohol, gray.

Station 146, 1375 fathoms, 12 + specimens. Station 147, 1600 fathoms, 12 + specimens. Station 157, 1950 fathoms, 12 + specimens. Station 158, (same species ?) 1800 fathoms, 1 very large specimen. Station 160, 2600 fathoms, 1 specimen.

Ophioglypha fraterna sp. nov.

Plate IV. Fig. 112.

Special Marks. — Five very minute, blunt arm-spines, which often are rubbed off or naturally wanting. Disk smooth and flat, with scales, radial shields, and mouth-shields all small, and obscured by skin. No arm-comb.

Description of an Individual (Station 157). — Diameter of disk 23.5 mm. Width of arm close to disk 3.7 mm. Mouth-papillæ short, squarish, closely joined together, seven or eight on each side, diminishing in size inward, with three pointed and longer at apex of jaw. Mouth-shield small, broader than long, pentagonal, with outer edge rounded and obtuse angle within; length to breadth 3 : 3. Side mouth-shields occupying the inner angle of the mouth-shield, and passing beyond it; narrower without than within, where they meet. First under arm-plate much broader than long, with outer edge curved; second plate six-sided, with inner laterals longest; beyond the disk they are very broad, triangular, with long sharp lateral angles, an obtuse angle inward, and the outer side curved. Often the lateral corners are broken off, and form separate pieces. Side arm-plates broad, not swollen, meeting below beyond the disk; separated above by the upper arm-plates, which are broader than long, and broader without than within, having the outer edge wavy. Disk high and

irregularly arched, covered above and below with a thick skin, which almost entirely obscures the fine disk-scales and the radial shields, which may be recognized as small, oval, smooth patches near the disk margin, on either side of the arm. Along the edge of the genital opening is a row of minute, closely joined squarish papillæ, which extend only to the margin of the disk, the arm-comb being absent. Five very minute, blunt arm-spines, three situated low on the edge of side arm-plate and two above. Often they are rubbed off, and there seem to be none. Tentacle-scales of the mouth-tentacles similar to mouth-papillæ and on one side, closely continuous with them ; on the first pair there are four or five scales on each side ; on the second five or six on each side ; just outside the disk there are four scales on the inner side and none on the other ; and a short distance beyond there are no scales. Color in alcohol, light gray.

Station 157, 1950 fathoms, 4 specimens.

Ophioglypha elevata sp. nov.

Plate IV. Figs. 87 - 89.

Special Marks. — Disk high and arched. Arms short and thick. Each under arm-plate has a median, elongated, bead-like swelling.

Description of an Individual (Station 145). — Diameter of disk 6 mm. Length of arm about 11mm. Width of arm close to disk, without spines, 1.3 mm. Five short, square, closely joined mouth-papillæ on each side, and one longer diamond-shaped at apex of jaw. Mouth-shield longer than wide, broader without than within, deeply constricted at the sides, and curved at both ends ; length to breadth 1 : .7. Side mouth-shields narrow, of even width, curving round the inner lobe of the mouth-shield and meeting within. First under arm-plate triangular, with angle inward and outer side curved ; second, third, and fourth plates four-sided, with outer edge, which is wider than inner, curved, and lateral sides re-enteringly curved. There is a longitudinal swelling on the under arm-plates which forms a continuous ridge within the disk. Side arm-plates wide, little swollen, constricted within, not meeting below on basal joints ; separated above by the upper arm-plates, which are four-sided, much broader than long, wider without than within, with outer and inner edges straight, and lateral sides re-enteringly curved. Disk thick and arched, covered with small, swollen, irregular scales, with one large pentagonal primary plate in centre. Radial shields small, as wide as long, irregularly triangular, joined their entire length ; length to breadth .7 : .7. Lower interbrachial space filled with small rounded scales ; along the free edge of the genital scale is a row of very minute pointed papillæ, which suddenly become long and spine-like as they pass upward to make the arm-comb. Five short blunt arm-spines, three well up on the edge of the side arm-plate, and two somewhat shorter close to tentacle-pores. On the mouth-tentacle pores there are two large scales on either side ; the other pores within the disk have three long rounded scales on the inner side, and one very wide, thick, erect scale on the

outer side, the latter being sometimes in two pieces ; beyond the disk there are on each pore a larger and a smaller short curved scale. Color in alcohol, light brown.

Station 145, 310 fathoms, 1 specimen.

Ophioglypha bullata Wyv. Thom.

Ophioglypha bullata Wyv. Thom., Nature, Vol. VIII. p. 400, Sep., 1873, with figure. Voyage of the "Challenger." The Atlantic, I. p. 400, with figures.

Plate III. Figs. 85, 86.

Special Marks. — Three minute, evenly spaced arm-spines. Disk-scales above rounded, and of various sizes, with large marginal plates. Disk high. Basal under arm-plates about as long as broad. Arms high and rounded.

Description of an Individual (Station 61). — Diameter of disk 11 mm. Length of arm 23 mm. Width of arm close to disk 2 mm. Four or five small, conical, widely separated mouth-papillae on each side, and three larger at apex of jaw. Mouth-shield very large, long pentagonal, with an obtuse angle inward much wider without than within ; outer lateral corners rounded ; length to breadth 2.7 : 2.3. Side mouth-shields pointed oval, small, meeting widely within. First under arm-plate triangular, with sharp angle inward and outer edge curved ; the rest within the disk four-sided, with inner edge slightly wider than outer, and lateral side a little re-enteringly curved ; beyond they gradually become wide hexagonal. Side arm-plates swollen, not meeting below till half a dozen joints beyond the disk ; separated above by upper arm-plates, which are much swollen, forming a high ridge ; the first two or three nearly square with rounded corners ; those just beyond rounded hexagonal ; and only near the middle of the arm do they become triangular, with an angle within and outer edge curved. Disk thick and arched ; in centre of upper surface a cluster of six large, round primary plates, separated by an irregular row of smaller ; between inner ends of radial shields and in each interbrachial space a conspicuous round plate ; on the margin are two plates connecting outer ends of genital scales, and within these a large plate connecting outer ends of radial shields ; rest of upper surface covered with small, swollen, rounded scales. Radial shields longer than broad, rounded pear-seed shape, forming a well-marked notch over arm ; separated their entire length by a single or double row of rounded scales ; length to breadth 2.7 : 2. The under interbrachial space is occupied by the large mouth-shield, the lower edges of the two small marginal plates, and the large genital scales, which are very narrow within, widening without, as they extend upward over the arm, bearing on the free edge a close row of square, flat papillæ, which begin at the third arm-plate and maintain the same shape in the arm-comb. Three minute pointed arm-spines, evenly spaced ; the lowest next the tentacle-scales. Tentacle-pores oval and very large ; four short rounded scales on each side of mouth-tentacles ; the rest, within and well beyond the disk, have four or more on the inner side, and

one or two on the outer side. The entire surface is microscopically tuberculous. Color in alcohol, straw.

Station 45, 1240 fathoms, (young.) Station 54, 2650 fathoms, 8 specimens. Station 61, 2850 fathoms, 12 + specimens. Station 133, 1900 fathoms, 5 specimens.

Ophioglypha convexa sp. nov.

Plate III. Figs. 83, 84.

Special Marks. — Three small tapering arm-spines. Disk covered above by a rosette of large angular primary plates, radial shields, and a few large interbrachial plates.

Description of an Individual (Station 241). — Diameter of disk 12 mm. Length of arm 30 mm. Width of arm close to disk, without spines, 3 mm. Mouth-papillæ small, conical, four to six on each side, and three larger at angle of jaw. Mouth-shield large, much longer than wide, five-sided, with an angle inward, and outer edge, which is wider than inner, much curved ; length to breadth 4 : 3.5. Side mouth-shields short, wider within than without, meeting broadly and occupying only the inner angle of the mouth-shield. First under arm-plate three-sided, with truncated angles ; beyond they are nearly square, with truncated corners and their lateral sides re-enteringly curved ; those farther out are octagonal, and afterwards hexagonal. Side arm-plates thick, swollen, meeting neither above nor below, except at end of arm. Upper arm-plates much broader than long, hexagonal, arched. Disk thick, covered above with a few stout plates. Radial shields angular, pear-seed shape, somewhat sunken, joined without but diverging inward, where they are separated by a thick wedge-like scale ; length to breadth 3 : 2. In the interbrachial spaces are five large plates, two on margin of disk, connecting the outer ends of the genital scales ; one quadrangular, connecting the radial shields ; and two smaller, which lie between inner ends of radial shields. The central space is covered by six regular, stout primary plates, elevated above the rest, the central one pentagonal, the others hexagonal. The genital scales fill the lower interbrachial space between mouth-shield and arm, and bear on their free edge a close row of square papillæ, which become peg-like on the arm-comb. Beyond the mouth-shield is a row of three small rounded marginal plates. Three short, delicate, tapering arm-spines, equally spaced. Tentacle-pores within the disk have two or three scales on the inner side, and one or more on the outer. Color in alcohol, yellowish-gray.

Station 241, 2300 fathoms, 2 specimens (young). Station 246, 2050 fathoms, 6 specimens. Station 346, 2350 fathoms, 4 specimens.

Ophioglypha sculptilis sp. nov.

Plate IV. Figs. 115, 116.

Special Marks. — Six minute arm-spines. First under arm-plate broader than long ; those beyond longer than broad. Radial shields separated within

by a cluster of large scales. Disk high. Basal under arm-plates about as long as broad. Arms high and rounded.

Description of an Individual (Station 237). — Diameter of disk 12.5 mm. Width of arm close to disk 3 mm. Mouth-papillæ five on each side, broader than long, shaped like blunt saw-teeth, with two blunt pointed papillæ at apex of jaw. Mouth-shield much rounded, pentagonal, with an angle inward, and two outer angles almost blended in a wide curve ; length to breadth 3.5 : 2.5. Side mouth-shields narrow, curved, pointed within, where they broadly meet. The first under arm-plate broad triangular, with outer edge curved, and a blunt angle within ; the next three long axe-shape, with outer edge, which is wider than inner, slightly curved, and lateral sides re-enteringly curved ; beyond the disk they are similar, but present an angle inward. Side arm-plates minutely tuberculous, broad, and swollen, meeting below at some distance beyond the disk ; separated above by upper arm-plates, of which the first is much wider than long ; the second wide semicircular, with outer edge curved ; the third narrower, with outer edge curved, and wider than the inner ; the rest rounded diamond-shape, with the inner angle longer than the outer. Disk thick, covered with thin flat plates ; in the centre is a large round primary plate, surrounded by five smaller, separated by two or three rows of fine scales ; in the interbrachial spaces are three large plates in a line, of which the outer is marginal and has usually a round plate on either side. Radial shields irregular blunt pear-seed shape, touching without, diverging inward, where they are separated by a wedge of three or four small rounded scales. Genital scales narrow within, growing much wider without ; bearing on their free edge a close row of squarish papillæ, which become spiniform where they pass upward to form the arm-comb. Six minute blunt arm-spines, equally spaced along the side arm-plate. Four or five small blunt tentacle-scales on each side of pores within the disk ; beyond the disk they soon diminish to two standing inside of pore. Color in alcohol, light gray.

Station 237, 1875 fathoms, 2 specimens.

Ophioglypha variabilis.

Plate III. Figs. 70, 78, 79.

Special Marks. — Four or five minute arm-spines. Under arm-plates longer than broad. Radial shields separated at inner ends by a single scale. Disk high. Basal under arm-plates about as long as broad. Arms high and rounded.

Description of an Individual (Station 195). — Diameter of disk 11.5 mm. Length of arm about 40 mm. Width of arm close to disk 2.7 mm. Mouth-papillæ six on each side, of which three are square and three pointed and one larger and diamond-shaped at apex of jaw ; they are all low and somewhat irregular. Mouth-shield blunt pear-seed shape with an angle within, or of a much rounded pentagonal form with an angle within and a curve without ;

length to breadth 3.3 : 2.7. Side mouth-shields narrow, meeting within and there forming a sharp angle. First under arm-plate triangular, outer edge curved, inner angle blunt; the next three plates are long axe-shaped, with outer edge, which is wider than inner, curved, and re-entering curves on the lateral sides; those beyond are separated by side arm-plates, and are pentagonal, with an angle inward, and outer side curved. Side arm-plates broad, somewhat swollen, meeting below beyond the fourth under arm-plate, and above beyond the fourth upper arm-plate, where they form almost the entire covering of the arm, having an angle inward and a curve without; the first three are broader and have the inner angle truncated. Disk thick, rather flat, covered above with thin, closely overlapping scales; a cluster in the centre of one large rounded primary plate and one smaller to each brachial space, separated by two or three rows of much smaller scales; in the interbrachial spaces are three large plates, — an oval marginal, connecting the outer ends of the genital scales; a second inside, joining the radial shields by a line of small scales; and a third, smaller and more rounded, which lies between the inner ends of the radial shields. Radial shields three-sided, with corners much rounded and a blunt angle inward, touching without, diverging inward, where they are separated by a small rounded scale; length to breadth 2.5 : 2. The under surface is occupied by the large mouth-shield; three to five small plates, just outside, and the broad genital scales, which, starting very narrow from the lateral side of the mouth-shield, increase in width as they curve upward over the arm; along their free edge, on the under surface, is a close row of large square papillæ, which become spiniform on the arm-comb. Four or five minute, round, pointed arm-spines, evenly spaced along edge of side arm-plate. Tentacle-pores very large, the basal ones oval, the rest round; those of the mouth-tentacles have three or four scales on each side; the next two sets, three on either side, those next the arm-plate being larger than the others; just beyond the disk they have two small scales on the inner edge, and one larger one next the arm-plate, and further out there are no scales. Color in alcohol, gray.

Station 195, 1425 fathoms, 5 specimens. Station 24, (same species?) 390 fathoms, 2 specimens (young).

Ophioglypha ornata sp. nov.

Plate IV. Figs. 113, 114.

Special Marks. — Three or four minute, widely spaced arm-spines. Mouth-shield trefoil, with a pointed lobe inward. Disk high. Basal under arm-plates about as long as broad. Arms high and rounded.

Description of an Individual (Station 216). — Diameter of disk 10 mm. Width of arm close to disk 3 mm. Five or six short, square, close-set mouth-papillæ on each side, the outer ones wider than the inner, with two pointed ones at apex of jaw. Mouth-shield large, much rounded triangular, with a

lateral constriction which makes a pointed lobe inward; length to breadth 2.7 : 2.5. Side mouth-shields long, crooked, and very narrow, meeting within. First and second under arm-plates larger than those beyond, axe-shaped, with outer edge wide and curved, and lateral sides re-enteringly curved; those beyond are similar, but present an angle inward. Side arm-plates swollen, broad, minutely tuberculated, meeting below, outside the disk; separated above by upper arm-plates, which are narrow, four-sided, much swollen, with curved lateral and straight outer and inner sides; towards the middle of the arm they become longitudinal oval. Disk thick, smooth, and angular, covered in the centre by small, thin, irregular, overlapping scales, in the midst of which are the six primary plates, which are rounded and rather small. In each interbrachial space, and connecting the radial shields, is a large rounded angular plate. Outside of this are two large marginal plates, which extend below nearly or quite to the outer edge of the mouth-shield. Radial shields much rounded triangular, broadly meeting without, separated within by two or three disk-scales; length to breadth 2 : 1.7. Interbrachial spaces below covered by the two great marginal plates, between which and the mouth-shield there are sometimes two or three small scales. Genital scales rather wide, and carrying on the free edge a row of large, square, close-set papillæ, which become spiniform where they form the arm-comb. Usually three, rarely four, very minute arm-spines, one at the top, one near the middle, and one at the lower edge of the side arm-plate. Three or four small rounded tentacle-scales on each side of first three sets of tentacle-pores; those just beyond the disk have two or three scales on the inner, and two on the outer side. Color in alcohol, light gray.

Station 216, 2000 fathoms, 2 specimens.

Ophioglypha Lacazei sp. nov.

Plate III. Figs. 58-60.

Special Marks. — Three minute arm-spines, high up. Radial shields rounded, separated by one scale within. One large marginal plate, with small scales about it. Disk high. Basal under arm-plates about as long as broad. Arms high and rounded.

Description of an Individual (Station 160). — Diameter of disk 11 mm. Length of arm about 30 mm. Width of arm close to disk 2.3 mm. Mouth-papillæ very small and widely separated; eleven to thirteen to each angle; one large at apex of jaw. Mouth-shield large, much rounded pentagonal, with obtuse angle inward, and outer side curved; length to breadth 2.5 : 2.5. Side mouth-shields rather short and wide, meeting within, where they are broader than without. First under arm-plate long, wedge-shape, with outer edge curved; the rest axe-shaped, with outer edge curved, and lateral sides re-enteringly curved. Side arm-plates regular and scarcely swollen. Upper arm-plates large, broader than long, hexagonal, with outer angles much rounded; length to breadth 1 : 1.3. Farther out they become nearly semi-

circular, with the curve inward. Disk covered with rounded, flat, thin, closely joined plates, among which may be seen a central rosette of primaries, and two larger plates in each interbrachial space. Radial shields short, wide, rudely semicircular, touching along part of their length, separated within by small wedge-like scales. The interbrachial space on the under surface is nearly covered by the large mouth-shield. The genital scales are broad and slightly curved, and bear rather stout tooth-like papillæ. Outside the mouth-shield are two rows of small thin semicircular scales. The papillæ of the arm-comb are flat, squarish, and separated, and are borne by a semicircular plate about as broad as long. Three minute arm-spines, pointed and standing well up on the outer edge of the side arm-plate. Tentacle-scales of the innermost pair of pores small, semicircular, usually two on either side. The rest of the tentacle-pores have usually one large on the outer side, and three or four smaller on the inner side. Color in alcohol, nearly white.

Station 160, 2600 fathoms, 5 specimens. Station 299, 2160 fathoms, 3 specimens.

Ophioglypha lienosa sp. nov.

Plate III. Figs. 80-82.

Special Marks. — Three minute arm-spines. Disk covered by small irregular scales, small separated radial shields, and very large mouth-shields. Disk high. Basal under arm-plates about as long as broad. Arms high and rounded.

Description of an Individual (Station 157). — Diameter of disk 15 mm. Length of arm about 37 mm. Width of arm, without spines, close to disk 3.5 mm. Mouth-papillæ small, conical, widely spaced, diminishing in size from within outward ; about five on each side and a group of three larger ones at apex of jaw. Mouth-shields very long, pentagonal, with an obtuse angle inward, lateral sides re-enteringly curved, and outer edge rounded ; length to breadth 3.5 : 3. Side mouth-shields short, meeting broadly within, where they are wider than without ; occupying only the inner end of the mouth-shields. First under arm-plate triangular, with an angle inward, and outer edge curved ; beyond, the plates are four-sided, thick, with outer and inner edges nearly straight, and lateral sides re-enteringly curved ; beyond the disk they become hexagonal ; their surface has a minutely crystalline appearance. Side arm-plates swollen, and not meeting below for some distance beyond disk. Upper arm-plates broader than long, thick and swollen, with outer side curved and longer than the inner, which is nearly straight ; lateral sides re-enteringly curved. Beyond, they are bounded by a long curve within and a peak without. Disk smooth, arched, and very thick, covered above with small thin plates, having a minutely tuberculous or crystalline appearance ; in the centre are six circular primary plates, separated by others irregularly shaped and angular, which also fill the interbrachial spaces. Radial shields small, short, and thick, rounded triangular, with an angle outward, separated their entire

length by a round plate without and several smaller plates within. Interbrachial space below chiefly covered by the great mouth-shields, outside which are three or four rows of small scales, and on either side a genital scale, bearing on the free edge broad, square, close-set papillæ, which become narrower where they form the arm-comb, on the broadened outer end of the genital scale. Three small sharp arm-spines, one situated in a notch well up on the outer edge of the side arm-plate, the other two lower, near junction of side with under arm-plate. Tentacle-pores very large, transverse oval in shape; on those of the mouth-tentacles four rounded scales on the under arm-plate, and three on the other side; the other pores within disk have usually four on the inner side, and one wide scale on the outer. Color in alcohol, body gray, arms straw-color.

Station 157, 1950 fathoms, 4 specimens.

Ophioglypha radiata sp. nov.

Plate III. Figs. 65, 66.

Special Marks. — Two minute arm-spines. Mouth-shield trefoil. Under arm-plates axe-shape. Radial shields small and rounded. Disk high. Basal under arm-plates about as long as broad. Arms high and rounded.

Description of an Individual (Station 205). — Diameter of disk 8.5 mm. Length of arm 35.5 mm. Width of arm close to disk 3 mm. Four or five wide, rectangular, closely set mouth-papillæ on either side, with three long and pointed at apex of jaw. Mouth-shields large, trefoil-shape, with a pointed lobe inward. Side mouth-shields very narrow, of even width and meeting within. First under arm-plate largest of all, triangular, with an angle within and outer edge much curved; the other plates are axe-shaped, with re-entering lateral sides and curved outer side; the first three touch each other. Side arm-plates thick, swollen, and minutely tuberculous, meeting on the under surface beyond the third plate. Upper arm-plates much swollen, the first two rounded hexagonal, those beyond rounded triangular. Disk high and rounded, covered with fine overlapping scales, of which the marginal are the larger. Radial shields small, broader than long, four-sided, with rounded corners, outer edges straight, touching nearly their whole length, diverging inward, where they are separated by a small triangular plate. There are small round primary plates, widely separated by the finer disk-scales. Genital scales short, wider without than within, bearing along their entire margin long, flat, and closely set papillæ, about fourteen in number; those towards upper surface much narrower than the under ones. Two very minute arm-spines, one situated low on the edge of the side arm-plate, next the tentacle-pore, the other half-way up the arm. Tentacle-scales curved; from three to four on either side of the large pores on the basal joints. Color in alcohol, pale yellow.

Station 205, 1050 fathoms, 6 specimens.

Ophioglypha undata sp. nov.

Plate IV. Figs. 101, 102.

Special Marks. — Four minute blunt arm-spines. Disk-plates rough and lumpy, with rosette of large primaries. Under arm-plates pentagonal. Disk high. Basal under arm-plates about as long as broad. Arms high and rounded.

Description of an Individual (Station 176). — Diameter of disk 3.5 mm. Width of arm close to disk 1 mm. Five mouth-papillæ on either side, of which the three outer ones are squarish, and the two innermost pointed and similar to the large one at apex of jaw. Mouth-shields five-sided, with outer lateral corners curved and a blunt angle within ; length to breadth .7 : .5. Side mouth-shields rather large, longer than wide ; wider without than within, where they meet. First under arm-plate long, three-sided, with angles much rounded and lateral sides re-enteringly curved ; second and third five-sided, with outer corners rounded, an angle inward, and lateral sides re-enteringly curved ; those beyond grow rapidly smaller, but have the same general form. Side arm-plates much swollen, but constricted at their inner margin, meeting widely above and below beyond the disk. The first upper arm-plate is triangular, with outer edge curved ; the second diamond-shaped, having the inner angle slightly truncated ; beyond this they become rapidly smaller and are diamond-shaped. Disk-plates above thick, and overlapping like tiles ; in the centre is a rosette of the six primary plates, the middle one being pentagonal, and those surrounding it transverse oval ; on the outer edge of each of these latter plates are one large and two smaller semicircular plates ; in the interbrachial spaces are two large rounded plates, the outer one extending quite to the margin of the disk. Radial shields about as broad as long, angular, closely soldered together. On the under surface the plates are rounded, and so much swollen as to form knobs with furrows between, the three along the margin being larger than the others. Genital scales narrow, with a row of seven or eight pointed papillæ on the free edge, while the papillæ of the arm-comb are longer and more slender. Four minute blunt arm-spines on the basal joints. The pores of the mouth-tentacles do not open into the mouth-slit : they have three rounded scales on either side ; the next two have two scales on either side, and beyond two on the inner and one on the outer side. Color in alcohol, gray.

Station 176, 1450 fathoms, 1 specimen.

Ophioglypha lapidaria sp. nov.

Plate III. Figs. 67 - 69.

Special Marks. — Eleven short, pointed, close-set arm-spines. Mouth-shields trefoil. Under arm-plates squarish. About eight tentacle-scales to each pore within the disk. Disk high. Basal under arm-plates about as long as broad.

Description of an Individual (Station 235). — Diameter of disk 11 mm. Width of arm close to disk 2.5 mm. Five or six short square mouth-papillæ on each side, and a cluster of two or three larger at apex of jaw. Mouth-

shields longer than broad; wider without than within, where they present a rounded angle; outer corners also rounded; on the lateral sides a constriction which gives them a three-lobed aspect; length to breadth 2.5 : 2.3. Side mouth-shields small, long, very narrow; outer end slightly broader than the inner, where they meet. First under arm-plate triangular, with truncated angle inward and outer edge curved; the next four are four-sided, with curved outer edge; beyond the disk they are pentagonal, with an obtuse angle inward, short lateral sides, and a long curved outer side. Side arm-plates thick, deeply constricted at their inner end; not meeting below till some distance beyond the disk, separated above by upper arm-plates, which are broader than long, wider without than within, the outer edge being curved. Disk thick, covered with large, closely soldered plates and scales. Radial shields pear-seed shape, longer than wide, with an angle within and outer edges rounded; touching without, separated within by a single wedge-like plate; in the centre above is a close rosette, consisting of a pentagonal primary plate, surrounded by five others, smaller and of an irregular shape; the remaining interbrachial space on the upper surface is occupied by rows of semicircular plates. Lower interbrachial space, covered by small curved, overlapping plates. Genital scales very narrow, except without, where they broaden into a wide radial scale, bearing a comb of short spines, which continue below as minute papillæ on the margin of the genital opening. Ten or twelve fine, short, blunt arm-spines, extending in a close continuous row along outer edge of side arm-plate. Tentacle-scales short, square, large, and thin. The pores of the mouth-tentacles carry five or six on each side; the pores immediately beyond are very large, and have about four on each side; beyond the disk they have three or four on the inner side, and one spiniform on the under arm-plate. Color in alcohol, light gray.

Station 235, 565 fathoms, 1 specimen.

Ophioglypha solida sp. nov.

Plate V. Figs. 120-122.

Special Marks. — Basal under arm-plates, beyond the second, about as long as broad, squarish, and with water-pores between them. Arms high, with swollen upper arm-plates and very small spines. Upper disk covered in great part by a rosette of primary plates and by radial shields.

Description of an Individual (Station 192). — Diameter of disk 10.5 mm. Width of arm close to disk, without spines, 3 mm. Eight minute, widely separated, pointed mouth-papillæ on each side of angle, with a cluster of three bluntly pointed at apex of jaw. Mouth-shields narrow, pear-seed shaped, with sharp angle inward, and outer edge much rounded; length to breadth 2 : 1.5. Side mouth-shields longer than broad, much wider without than within, where they meet, extending nearly two thirds of the distance on sides of mouth-shield. First under arm-plate three-sided, longer than wide, with rounded angle inward, and a slight re-entering curve on all three sides; the next six or

seven plates are broader than long, octagonal, and separated by wide pores or depressions; the remainder of the under arm-plates are quadrangular, with an angle within and without. Side arm-plates broad and somewhat swollen, meeting below only towards the tip of the arm; separated above by the upper arm-plates, which are broader than long, and four-sided, with lateral sides straight, and outer edge much wider than inner, and curved; towards the tip of the arm they are diamond-shape, with truncated angles without and within. Disk round and high, covered with large, much swollen plates, the central primary being pentagonal, surrounded by five others, large and more or less rounded; in the upper interbrachial space are two plates, the inner one rounded; the outer marginal one much broader than long, and somewhat swollen. Radial shields joined, small, and irregular in shape, curved without. Lower interbrachial space covered by two much swollen plates, longer than wide, extending from the outer edge of the mouth-shield to the marginal plate. Genital scales much longer than wide, wider without, tapering inward, carrying along their free edge, from the outer edge of the mouth-shield to the edge of the arm-comb, a row of minute papillæ, which become somewhat longer as they appear above the arm to form the comb. Two, and sometimes three, small, delicately tapering arm-spines, about half as long as a joint. Tentacle-scales on first pair of pores, three on either side; on the second, three or four on the interbrachial side, and two on the brachial; third pair the same, but only one on the brachial; beyond there are three long blunt scales on the interbrachial side. Color in alcohol, white.

Although from only 129 fathoms, this species has the look of a deep-sea inhabitant.

Station 192, 129 fathoms, 1 specimen.

Ophioglypha rugosa sp. nov.

Plate IV. Figs. 90, 91.

Special Marks. — Disk covered with much swollen, lumpy plates. Genital scales wide, thick, and in a single piece. Basal under arm-plates longer than wide. Papillæ of arm-comb short, flat, close-set, and with rounded ends.

Description of an Individual (Station 169). — Diameter of disk 7 mm. Width of arm close to disk 1.5 mm. Four short tooth-like mouth-papillæ on each side, with one larger at apex of jaw. Mouth-shields pentagonal; outer and lateral sides straight, with very blunt angle within; outer corners rounded; length to breadth 1.3 : 1. Side mouth-shields narrow, with a wavy outline, meeting within. First under arm-plate triangular, with an angle within and outer side curved; second plate longer, with inner angle truncated; beyond this they are pentagonal, with outer side curved, lateral sides re-enteringly curved, and an angle within. Side arm-plates broad, meeting below, but separated above, near base of arm, by the upper arm-plates, which are long wedge-shape, with outer edge curved, and an angle within, except the first two, which have the inner angle truncated. Disk angular, covered with large,

much swollen plates, having deep furrows between them ; in centre a group of six primary plates, separated by a row of irregular smaller plates ; outside of these is another circle of ten equally large plates, of which the brachial ones separate the inner ends of the radial shields. In each interbrachial space there is also a large marginal plate. Radial shields longer than broad, outer edge much wider than inner, joined without, but widely separated within by a large rounded plate. Length to breadth 2 : 1. On the under surface the plates are not so much swollen, and more regular ; in each interbrachial space are about three concentric rows, of from three to five plates each. Genital plates long and rather wide, with outer end wider than inner ; along the free edge is a close row of fine, even, tooth-like papillæ, which become somewhat longer and wider as they pass upward to form the arm-comb. Three arm-spines short, blunt, and equally distant from each other. On first two sets of pores four tentacle-scales on each side ; the third has three on each side ; the fourth, one on the outside and three on the inside ; a little beyond the disk there is only one on the inside. Color in alcohol, white.

Station 169, 700 fathoms, 4 specimens.

Ophioglypha ponderosa sp. nov.

Plate II. Figs. 52 - 54.

Special Marks. — Disk-plates high and excessively swollen. Upper arm-plates rising in a high sharp ridge. Arm-spines minute, close-set, and like little blocks.

Description of an Individual (Station 232). — Diameter of disk 32 mm. Width of arm at disk 6 mm. Mouth-papillæ square, flat, crowded, forming a continuous row with the scales of the mouth-tentacles, four or five on each side, with three or four longer and pointed papillæ at angle of jaw. Mouth-shield long and narrow, with outer end much rounded, lateral sides having a slightly re-entering curve, and a short blunt angle within ; length to breadth 5.7 : 3. Side mouth-shields long triangular, outer edges broader ; inner ends tapering, where they meet. Under arm-plates broad hexagonal, with outer and inner ends straight, and short angles on the sides ; the first plate is similar, but not so large as the others ; farther out on the arm they become diamond-shaped. Side arm-plates swollen, with outer edge curved, not meeting either above or below. Upper arm-plates narrow, very highly arched, forming a sharp ridge ; length to breadth about equal, wider without than within, four-sided, with sides nearly straight. The upper surface of disk is covered by angular plates, excessively swollen and lumpy, and compactly soldered ; the plates in centre being smallest. Radial shields longer than wide, with edges irregularly curved, meeting without, diverging inward, where they are separated by a large plate of about the same size and shape ; in the interbrachial space, besides numerous smaller plates, is one roughly triangular, with one angle inward ; on the lower interbrachial space the scales are not so much swollen ; there are about half a

dozen, besides the genital plates, which are composed of three pieces, the outer one being the largest and thickest; along their entire edge from the mouth-shield to the outer edges of the radial shields is a row of fine, square, short papillæ, those nearest the mouth-shield being broader than long, while towards the radial shields they become very fine, much narrower than long; there is a group of similar papillæ on the free outer end of the side mouth-shield. The arm-spines are so short, thin, square, and closely soldered together as to look like a continuous narrow border to the side arm-plate; in shape they resemble the arm-comb, and are about eight in number. The pores of the mouth-tentacles have four or five scales on each side, similar to the mouth-papillæ; the second has seven similar scales on the interbrachial side, and four on the other; the third five and four; the fourth four and three; beyond this three only on the inner or interbrachial side. Color in alcohol, brownish-yellow.

Station 232, 340 fathoms, 1 specimen.

Ophioglypha minuta sp. nov.

Plate V. Figs. 117-119.

Special Marks. — Interbrachial space below covered by only one or two plates besides the genital scales. Upper arm-plates rudimentary or wanting.' Tentacle-pores of arm with only one rounded scale.

Description of an Individual (Station 158). — Diameter of disk 5.5 mm. Length of arm about 12 mm. Width of arm close to disk, without spines, 1 mm. Six short, squarish, closely set, longer than wide mouth-papillæ on sides of angle, and three short and bluntly pointed at apex of jaw. Mouth-shield as long as broad, having a slight constriction towards the inner end, which is an obtuse angle, outer side widely curved; length to breadth 1 : 1. Side mouth-shields longer than wide, meeting within, and there forming a long angle inward; outer edges narrower than inner. First under arm-plate triangular, with rounded angle inward, lateral sides having a slight re-entering curve, and outer edge gently curved. Second under arm-plate pentagonal, length and breadth about equal, having deep re-entering curves on the lateral sides, a narrow obtuse angle within, and outer side curved; beyond the second the plates are triangular in shape, having an angle inward and outer side curved, and they become rapidly less in size. Side arm-plates long and thick, beyond the second under arm-plate forming almost the entire covering of the arm, as there are no upper arm-plates. Disk flat and round, with a central group of six primary plates, whereof the middle one is pentagonal, while the five surrounding it are transverse oval; connecting these plates are minute triangular scales; the interbrachial spaces above are filled by two large plates, the inner one broader than long, with outer edge straight, and inner edge broader than outer; the marginal plate has the inner edge straight, and the outer curved; on either side of the marginal plate are two minute semicircular scales. Radial shields three-sided, longer than broad, joined their entire length; outer edges with a

slight re-entering curve ; interbrachial edges curved ; length to breadth 1.5 : 1.3. Interbrachial space below filled by a large slightly swollen plate, which is sometimes divided in two by a median line, and by the large, thick, longer than broad genital scales, along the free edge of which are eight or more very minute, short, blunt papillæ, extending to upper margin of disk, where they bear an arm-comb of two or three papillæ. Three short delicate arm-spines about two thirds the length of a joint, two low on the under surface of the arm, and one well up on its side. Tentacle-scales on the first set of pores, two on the interbrachial side and one on the brachial ; beyond this there is only one large scale on the inner side. Color in alcohol, white.

The proportionate size of the side arm-plates and small number of those of the disk show this to be a young specimen, but its characters are so well marked as to warrant a description, and its great depth gives it importance.

Station 158, 1800 fathoms, 1 specimen.

Ophioglypha inermis sp. nov.

Plate V. Figs. 123-125.

Special Marks. — No arm-comb, and only a feeble row of grains along the genital opening. Disk covered with thin overlapping scales and very small radial shields.

Description of an Individual (off Tristan d'Acunha). — Diameter of disk 14 mm. Length of arm about 70 mm. Width of arm close to disk, without spines, 2.5 mm. Mouth-papillæ small, short, pointed, and close-set, similar to and continuous with the tentacle-scales of the second pair of mouth-tentacles. If true mouth-papillæ be those that stand on the mouth-frames, there are eight or ten on either side and a cluster of three somewhat larger on the jaw-plate. Mouth-shield broader than long, with very blunt angle inward and outer edge curved ; length to breadth 2 : 2.7. Side mouth-shields longer than broad, of nearly equal width, nearly or quite meeting within. First under arm-plate small, longer than broad, hexagonal ; second plate broader than long, rounded quadrangular ; beyond this the plates become much broader than long, with sharp angles at the lateral sides, a small peak within, and a rounded angle without. Side arm-plates thin, not swollen, just meeting below beyond the fourth under arm-plate ; separated above by the large upper arm-plates, which are much broader than long, and wider without than within, with lateral sides straight, and outer corners rounded. Disk high and round, covered above and below with very thin, closely overlapping scales, with one minute circular primary plate in centre of disk. Radial shields small, nearly round, separated by a large angular plate ; length to breadth 1.3 : 1. Genital scales hidden ; along their free edge is a row of very minute, bead-like papillæ ; three slim, flat, pointed, nearly equal arm-spines, somewhat longer than an arm-joint, and equally spaced along the outer edge of the side arm-plate. The first pair of tentacle-pores, which open into the mouth-slit, have six or seven minute tentacle-scales, exactly like the mouth-papillæ, and arranged in an ox-bow

figure. The first arm-pores have three minute papillæ on either side; those beyond have only two long and rounded scales on the inner side of each pore. Color in alcohol, white.

It will be noted that *O. inermis* stands on the limit of *Ophioglypha;* while it has the general look and structure of the genus, it lacks wholly the arm-comb, and has only a trace of the papillæ along the genital scale below. It seems to go better here than with *Ophiocten.*

Two specimens, (also two young, this species?) off Tristan d'Acunha, 500 fathoms.

Ophioglypha Deshayesi sp. nov.

Plate II. Figs. 35-37.

Special Marks. — Side mouth-shields large and ovoid. Radial shields and primary plates circular and similar. Disk and arm plates thick, swollen, and closely soldered. Mouth-papillæ and scales of mouth-tentacles thick, squarish, irregular, and crowded.

Description of an Individual (Station 51). — Diameter of disk 18 mm. Length of arm 80 mm. Width of arm close to disk 4 mm. Mouth-papillæ irregular, crowded, angular, closely soldered, five or six on each side and usually one or two at apex of jaw. Mouth-shields small, with long, acute angle inward, and outer edge cleanly curved; length to breadth 3 : 2. Side mouth-shields large, narrow pear-seed shape, with the rounded ends inward, where they meet at one point. Inside the junction of the side mouth-shields is a small diamond-shaped supplementary plate, which makes the apex of an angle. First under arm-plate semicircular or transverse oval, with outer edge nearly straight; the plates beyond are wide triangular, with a truncated angle inward, and outer side a little curved. Side arm-plates swollen, nearly meeting below within the disk; separated above by the upper arm-plates, which are broader than long, arched, wider without than within, hexagonal, having outer angles more or less rounded. Disk very thick, covered with rounded plates somewhat obscured by a thick skin; in the centre above are six large primary plates separated by one or two rows of smaller ones, and in the interbrachial spaces are two larger plates, one marginal and the other inside it. Radial shields very nearly round, separated usually by three plates in a line; length to breadth 3 : 3; along their inner margin is a row of small irregular-shaped scales. Genital plates formed of two or more pieces, wider without, tapering inward; along the outer portion of their free edge is a row of small shapeless pieces, which become more numerous above, and there form a sort of arm-comb. One minute papilla-like arm-spine situated near the junction with the upper arm-plate. Pores of mouth-tentacles enclosed on one side by the two outer mouth-papillæ, with some other minute pieces; and on the other side by four or five similar parts, which correspond to tentacle-scales: the rest of the pores stand near the lateral corners of the under arm-plates, and have three small peg-like tentacle-scales. Color in alcohol, yellowish-brown or gray.

Station 150, 150 fathoms, 2 specimens. Station 151, 75 fathoms, 8 specimens. Christmas Harbor, Kerguelen Islands, 120 fathoms, 12 + specimens. Royal Sound, Kerguelen Islands, 28 fathoms, 12 + specimens.

Ophioglypha inornata sp. nov.

Plate II. Figs. 26, 27.

Special Marks. — Side mouth-shields small. Mouth-shield broader than long, with a peak inward. Disk and arm plates thick, swollen, and closely soldered. Mouth-papillæ and scales of mouth-tentacles thick, squarish, irregular, and crowded.

Description of an Individual (Station 106). — Diameter of disk 10 mm. Length of arm about 23 mm. Width of arm close to disk, without spines, 2 mm. Five or six short, bead-like, closely soldered mouth-papillæ on each side, with one much longer at apex of jaw. Mouth-shields broader than long, small, rounded triangular, with angle inward, and outer edge curved. Side mouth-shields short, pointed oval, occupying inner sides of the mouth-shield and meeting broadly within. First under arm-plate rounded, with a long curve within and an obtuse angle without ; second pentagonal, with an angle inward, outer side wide, and laterals re-enteringly curved ; beyond these the plates become broader than long, with an angle within and a curve without. Side arm-plates thick, slightly swollen, meeting broadly below ; separated above by upper arm-plates, which are thick, rather small, of a rounded diamond-shape, and as long as broad. Disk rather thick, swollen, covered with thick, minutely tuberculous plates. Radial shields irregular in form, inner edges nearly circular or oval, diverging inward, where they are separated by a single row of three scales ; in each interbrachial space is a marginal plate connecting the radial shields. In centre of disk above are six round, well-marked primary plates, separated from each other and from the radial shield by single lines of much smaller plates. Interbrachial space below covered chiefly by a large marginal plate, and two smaller between it and the mouth-shield. Genital plates short, thick, broader within, tapering outward, where they bear small, irregularly placed papillæ, which make above a sort of arm-comb. Arm-spines minute and hard to see, one near upper arm-plate and two or three near the under. Tentacle-scales minute ; on the pores of the mouth-tentacles are four on one side and three on the other ; the second pore, which is near the inner end of the arm-plate, has only three ; and the third two. Color in alcohol, gray.

Station 106, 1850 fathoms, 3 specimens.

Ophioglypha confragosa sp. nov.

Plate II. Figs. 38, 39 - 57

Special Marks. — Disk-plates irregular and humpy. A group of papillæ near the arm, on margin of interbrachial space. Disk and arm plates thick,

swollen, and closely soldered. Mouth-papillæ and scales of mouth-tentacles thick, squarish, irregular, and crowded.

Description of an Individual (Station 320). — Diameter of disk 14 mm. Width of arm close to disk 2.3 mm. Mouth-papillæ angular, closely soldered, four or five on each side, and one, diamond-shaped, at angle of jaw. Mouth-shield large, five-sided, with blunt angle inward, and outer edge slightly curved; length to breadth 2.3 : 2. Side mouth-shields narrow, of about even width, running along inner angle of mouth-shield and meeting within. First under arm-plate three-sided, with inner sides much curved and outer edge nearly straight; second and third also three-sided, having two re-entering curves on the lateral sides; beyond this they become broader than long, with outer edge so much curved as to give them a diamond-shaped appearance. Side arm-plates swollen, just meeting below and separated above by upper arm-plates, which are rounded, with outer and inner edges slightly flattened; farther out they become long hexagonal, with corners much rounded. Disk flat, covered with rounded raised plates, separated by deep furrows; in the centre are six primary plates surrounded by a row of smaller and more angular. In each interbrachial space above are two large plates, one on the margin. Radial shields blunt pear-seed shape, with the rounded end outward, separated widely by one large and one small plate. Genital plates composed of two or three pieces, the outer and principal piece long and narrow, tapering at each end, of which the outer is covered by a clump of small soldered papillæ, which pass upward and form a sort of arm-comb. The rest of the lower interbrachial space is covered by five large and as many small plates. Arm-spines minute and peg-like, one half-way up the side arm-plate, and one near the junction of the upper arm-plate with the side arm-plate. Three large, square, close-set tentacle-scales on either side of pores of mouth-tentacles; on the second pair one peg-like scale, and on the rest two similar scales. Color in alcohol, white.

Station 320, 600 fathoms, 12 + specimens.

Ophioglypha intorta sp. nov.

Plate II. Figs. 41-43.

Special Marks. — Side mouth-shields very narrow. A small arm-comb. Disk and arm plates thick, swollen, and closely soldered. Mouth-papillæ and scales of mouth-tentacles thick, squarish, irregular, and crowded.

Description of an Individual (off Marion Island). — Diameter of disk 9 mm. Length of arm 23 mm. Width of arm at disk 1.5 mm. Mouth-papillæ angular, closely soldered, five or six on each side, and a larger, diamond-shaped, at angle of jaw. Mouth-shield large, pentagonal, with a long angle within and outer edge rounded. Side mouth-shields long, narrow, curved, and tapering towards either end, scarcely meeting within. First under arm-plate triangular, with one angle inward, outer edge straight, and lateral sides curved; those beyond are wide pentagonal, with an angle within, and outer side a little curved. Side

arm-plates short and stout, scarcely meeting below within the disk, and separated above by the upper arm-plates, which are swollen, broader than long, broader without than within, with a curved outer edge. Disk flat, covered with raised, irregular-shaped, angular plates, having deep furrows between them. Radial shields ovoid in outline, with the smaller end inward, separated by a wedge of three or four plates. Genital plates long and narrow, much wider without than within ; along their free edge is a row of fine, short, upright papillæ, which pass upward and form an arm-comb. Two short, thick, and blunt arm-spines, one at centre of edge of the side arm-plate, and another near junction of the upper arm-plate. The pores of the mouth-tentacles have three or four scales like mouth-papillæ on each side ; beyond there are two scales shaped like the arm-spines. Color in alcohol, light gray.

Off Marion Island, 50 – 75 fathoms, 12 + specimens.

Ophioglypha Sarsii Lyman.

Ophiura Sarsii, Ltk. Vid. Meddel. Nov. 1854. p. 7.
Ophioglypha Sarsii, Ill. Catal. Mus. C. Zoöl. p. 41, Figs. 2, 3.

Station 49, 83 fathoms, 12 + specimens.

Ophioglypha acervata Lyman.

Ophioglypha acervata, Bull. Mus. C. Zoöl. I. No. 10, p. 316. 1869.

Station 122, 350 fathoms, 3 specimens.

Ophioglypha sinensis Lyman.

Ophioglypha sinensis, Ill. Catal. Mus. C. Zoöl. No. VI. p. 12, Pl. I. Figs. 1, 2. 1871.

Off Yokohama, Japan, 8 – 14 fathoms, 7 specimens. Station 233 *b*, 15 fathoms, 8 specimens.

Ophioglypha falcifera Lyman.

Ophioglypha falcifera, Bull. Mus. C. Zoöl. I. No. 10, p. 319. 1869.

Station 24, 390 fathoms, 1 specimen.

Ophioglypha hexactis E. A. Smith.

Ophioglypha hexactis, Ann. & Mag. of N. H. 1876, Feb. XVII. p. 3.

Balfour Bay, 20 – 60 fathoms, 1 specimen. Betsey Cove, 20 – 25 fathoms, 12 + specimens. Royal Sound, 25 fathoms, 12 + specimens. All localities in Kerguelen Islands. Also off Marion Island, 50 – 75 fathoms, 12 + specimens.

Ophioglypha multispina Ljn.

Ophioglypha multispina, Ophiuroidea Viventia. Öf. Kong. Akad. p. 307. 1866.

Port Jackson, 30 – 35 fathoms, 11 specimens.

Ophioglypha Lymani Ljn.

Ophioglypha Lymani, Om tvänne nya arter. Öf. Kong. Akad. No. 5, p. 472. 1870.

Station 304, 45 fathoms, 2 specimens. Station 305, 120 fathoms, 12 specimens. Station 307, 147 fathoms, 12 + specimens. Station 308, 175 fathoms, 1 specimen. Station 309, 40 – 140 fathoms, 3 specimens. Station 311, 245 fathoms, 1 specimen. Station 313, 50 fathoms, 12 + specimens.

OPHIOCTEN Ltk.

Ophiocten amitinum sp. nov.

Plate V. Figs. 129, 130.

Special Marks. — Primary and marginal disk-plates large and conspicuous. Arm-comb and papillæ on first two upper arm-plates well marked. Two minute tentacle-scales.

Description of an Individual (Kerguelen Islands). — Diameter of disk 7 mm. Length of arm about 35 mm. Width of arm without spines 1.5 mm. Four short blunt mouth-papillæ on each side, and one longer and pointed at apex of jaw. Mouth-shield large, pentagonal, broader within than without, having a wide angle within, and outer corners curved ; length to breadth 1 .3 : 1 .4. Side mouth-shields small, broader without than within, where they meet and are often somewhat separated from the mouth-shield. First under arm-plate large, rounded triangular, with outer edge straight ; the remaining plates small and three-sided, much wider than long, with outer edges strongly curved and inner laterals re-enteringly curved, the whole presenting almost a crescent shape ; they become very small towards tip of arm. Side arm-plates broad, flaring somewhat outward, meeting broadly below ; separated above by the upper arm-plates, which are broader than long, with lateral sides straight, and outer edge, which is wider than inner, curved. Disk round, flat, and rather thick, covered with thin flat scales and plates of various sizes, among which are six rounded primaries, separated by single lines of small scales ; in the brachial space, just inside the radial shields, there is a transverse row of larger rounded scales ; in each interbrachial space are two separated plates similar to the primaries, and outside these, along margin of disk, is a row of four connected plates. Radial shields conspicuous, pear-seed shaped, widely separated by disk-scales. Outside the radial shields is an arm-comb of small, short-pointed papillæ, part carried on outer point of genital scale and part on outer edge of radial shield and on the scale between the radial shields ; besides these there is on the outer edge of the first three upper arm-plates a row of from three to five papillæ. Lower interbrachial space covered by regular rows of small, semicircular, overlapping scales, and by the genital scales, which are longer than broad, and slightly wider without than within, and sometimes carry on their free edge an irregular row of minute papillæ. First pair of tentacle-pores have two very small scales on the outer edge, the rest have one

on each side. Three long, slender, cylindrical, sharp, tapering arm-spines, situated close together low on the outer edge of the side arm-plates ; lengths to that of an arm-joint 1.2, .8, .6 : .6. Color in alcohol, white.

A young, with a disk of 3 mm., differed in having the upper disk covered almost entirely by the primary and the other large plates ; the intermediate disk-scales were just beginning to form. The radial shields were shorter, and the papillæ above the arm fewer.

Kerguelen Islands, 120 fathoms, 12 + specimens. Prince Edward's Island, 85 – 150 fathoms, 7 specimens (same species ?). Station 152, 1260 fathoms, 4 specimens.

Ophiocten umbraticum sp. nov.

Plate V. Figs. 131, 132.

Special Marks. — Primary and marginal disk-plates small, and the former widely separated. Arm-comb feeble. Tentacle-scales single and minute, or quite wanting.

Description of an Individual (Station 325). — Diameter of disk 9.5 mm. Width of arm close to disk, without spines, 1.3 mm. Four rather wide, closely joined mouth-papillæ, with one larger, diamond-shaped, at apex of the jaw. Mouth-shield very thin, triangular, broader than long, with blunt angle inward and corners rounded ; length to breadth 1 : 1.5. Side mouth-shields long and narrow, tapering inward, where they nearly or quite meet. First under arm-plate large, four-sided, the inner side being very short like a truncated angle, with corners rounded ; the rest of the under arm-plates are very small, nearly or quite semicircular, with a little peak inward. Side arm-plates slightly flaring outward, meeting broadly below, where they form most of the under surface of the arm ; separated above by upper arm-plates, which are four-sided, with outer edge wider than inner, and curved ; lateral sides slightly re-enteringly curved. Disk flat and thin, covered with small, transparent, delicate scales ; six small, rounded, widely separated primaries, one in the centre and one to each brachial space ; outside these there are two similar plates in each interbrachial space, one towards the centre and one near the margin ; along the margin there are two irregular rows of small plates, somewhat broader than long. Radial shields triangular, with a rounded angle inward, widely separated by the disk scaling ; length to breadth 1.5 : .8. Lower interbrachial space covered by delicate, nearly transparent scaling, which also hides the genital scales, except their outer tips, just outside the radial shields, which bear an arm-comb of three or four minute papillæ. Genital opening quite long, extending from the outer end of side mouth-shields to edge of disk. There are large tentacle-pores, but no scales on any of the pores. Near base of arm there are three small, delicately tapering arm-spines, situated on the outer edge of the side arm-plate ; the upper is about two thirds the length of an arm-joint and the lowest about half as long ; farther out there are but two spines. Color in alcohol, white.

On the above specimen no tentacle-scales could be seen, but on others some pores, at any rate, are furnished with a single minute one.

Station 325, 2650 fathoms, 7 specimens.

Ophiocten pallidum sp. nov.

Plate V. Figs. 126-128.

Special Marks. — Disk covered with minute thin scales, among which appear very small, widely separated primary plates. One minute tentacle-scale. Three short, equal, slender arm-spines.

Description of an Individual (Station 160). — Diameter of disk 14.5 mm. Length of arm about 70 mm. Width of arm close to disk, without spines, 1.7 mm. Five short, blunt, ill-defined mouth-papillæ on the side, and one larger at apex of jaw, like the three or four teeth that stand immediately above it. Mouth-shields much broader than long, bounded on the outer edge by a wide curve and by a very wide angle within; length to breadth 1.2 : 2.6. Side mouth-shields long and narrow, extending along the inner angle of the mouth-shield, and just meeting within, where they broaden slightly, becoming narrower at the outer end where attached to the side arm-plate. First under arm-plate much larger than the others, four-sided, with outer edge straight, lateral sides re-enteringly curved, and a short side, like a truncated angle within; the rest of the under arm-plates are very small, with a curved outer side, and are nearly semicircular in form, but have a slight peak inward at the junction of the side arm-plates, which are thin and wide, flaring slightly outward, meeting broadly below, and separated above by the upper arm-plates, which are four-sided, with outer edge nearly straight and wider than inner. Disk round, smooth, and flat, covered with minute, very thin, overlapping scales, four or five in the length of a mm. on upper surface, and more below; among them may be distinguished small, round, widely separated primary plates. Radial shields longer than broad, three-sided, with all three angles much rounded, widely separated their entire length by the disk scaling; length to breadth 2.6 : 1.5. Genital scales hidden, except the outer tip, which shows outside the radial shield, and bears no papillæ, or only one or two rudimentary. Three sharp, slender, tapering arm-spines, situated close to each other on the middle edge of the side arm-plate. Only one very minute, rounded tentacle-scale on the outer edge of some of the tentacle-pores; a little way out on the arm there usually is a minute scale on the inside of the pore, and none on the outer side. Color in alcohol, pale straw.

Station 160, 2600 fathoms, 12 + specimens. Station 156, 1975 fathoms, 4 specimens.

Ophiocten sericeum? Ljn.

Ophiura sericea Fbs.

Ophiocten Kröyeri Ltk.

Ophioglypha gracilis? (young) G. O. Sars.

Ophiocten sericeum seems not to differ essentially from *Ophioglypha gracilis*, except in having a comb of fine papillæ along the outer edges of the basal upper arm-plates; but this comb is wanting in the young, and not regular in the adult.

A young *O. sericeum* (disk 7.5 mm.) was very like a still smaller *O. gracilis* (disk 6.8 mm.), which had the arm-comb less marked ; but other specimens had it just the same. A number of specimens marked as *O. sericeum* (young) and *O. gracilis* showed variations in number of papillæ along the genital openings, coarseness of disk-scales, more or less pointed tentacle-scales, and length of spines ; but all these variations seem common to both, in a greater or less degree. The two specimens of the "Challenger" Expedition showed no valid difference with the half-grown *O. sericeum*, except in absence of papillæ along the genital opening ; but two specimens from George's Bank, off Massachusetts, were in this respect intermediate, and had hardly any papillæ in that region.

Off Marion Island, 50 – 75 fathoms, 2 specimens.

Ophiocten hastatum sp. nov.

Plate V. Figs. 133, 134.

Special Marks. — Disk with minute thin scales, among which appear well-marked primary plates. Three tapering arm-spines, the upper much the longest and largest. One minute tentacle-scale.

Description of an Individual (Station 146.) — Diameter of disk 9 mm. Width of arm close to disk 2 mm. Four or five short, squarish, close-set mouth-papillæ on each side, with one much larger at apex of jaw, having two small bead-like ones at its base. Mouth-shield rounded pentagonal, having a broad angle within. Side mouth-shields long and narrow, of about equal width, nearly or quite meeting within. First under arm-plate larger than any of the others, four-sided, with inner side much narrower than the outer, which is slightly rounded ; the remainder of the under arm-plates are much wider than long, and nearly semicircular, with a slight peak inward, and outer side deeply curved. Side arm-plates somewhat swollen and flaring outward, meeting broadly below ; separated above by the upper arm-plates, which are somewhat arched, with the inner side narrower than the outer, which is curved. Disk round, smooth, and flat, covered, above and below, with minute thin scales ; in the centre are several rounded primary plates, and one of nearly equal size in each interbrachial space. Radial shields pear-seed shape, with inner angle blunt, and outer corners rounded ; separated their entire length by fine overlapping scales. Genital scales hidden, except their tips, outside the radial shields, which bear an arm-comb of a few minute papillæ, as does sometimes the first upper arm-plate. Three slender, cylindrical, tapering, pointed arm-spines, the upper one being much longer and larger than the two lower ; lengths to that of an arm-joint 3.4, 1, .8 : 1. Tentacle-scales minute and rounded ; there are two or three to each of the second mouth-tentacles ; usually one on the outside of the basal pores, and one on the inside of the pores farther out on the arm. Color in alcohol, disk nearly white ; arms above pale gray.

Station 78, 1000 fathoms, 2 specimens. Station 146, 1375 fathoms, 12 + specimens. Station 168, 1100 fathoms, 12 + specimens.

OPHIOMASTUS * gen. nov.

Disk arched and extremely high, covered with a few large thick plates, among which the primaries are conspicuous for superior size. Arms short, with large thick side arm-plates. First under arm-plate similar to and nearly as large as those beyond. Mouth-papillæ arranged in a narrow close-set line; teeth rather slender; no tooth-papillæ. Small smooth arm-spines arranged along outer edge of side arm-plates. Two narrow genital openings in each interbrachial space.

Ophiomastus tegulitius sp. nov.

Plate VI. Figs. 167-169.

Special Marks. — Two very short, stout arm-spines. Disk-plates swollen and microscopically tuberculous. Side mouth-shield of a pointed ovoid shape.

Description of an Individual (Station 165). — Diameter of disk 4 mm. Length of arm about 6 mm. Width of arm close to disk, without spines, 1 mm. Mouth-papillæ so closely soldered as to form an almost continuous narrow line from side mouth-shields to apex; on either side is a long curved one, followed by two shorter, and by a narrow spine-like one at apex of angle. Mouth-shield pentagonal, with an angle inward, longer than wide; inner lateral sides straight, outer lateral corners rounded; length to breadth .7 : .5. Side mouth-shields large, swollen; broadest and rounded within, where they meet, then tapering outward along the inner lateral sides of the mouth-shields. Under arm-plates long pentagonal, with an angle inward, lateral sides re-enteringly curved, outer side slightly curved. Side arm-plates large, thick, and swollen, meeting below and above; upper arm-plates small, first one diamond-shaped, and second triangular with sharp angle inward and outer edge straight; the rest are similar, but grow rapidly smaller. Disk highly arched and rounded; in the centre a large hexagonal primary plate, surrounded by six others, much swollen, with inner and lateral sides nearly straight and outer edges rounded; these seven plates cover almost the entire upper surface of the disk; in the upper interbrachial space there is a rounded, much swollen marginal plate, and over the arm two small, joined, scale-like radial shields. On the under surface, outside the mouth-shield, there are two large plates, the outer and larger one connecting with the large marginal plate. Genital scale long and wide, and composed of three pieces. Tentacle-scales long, narrow, and curved, the one on the interbrachial side being semicircular, while the other on the lateral side of the under arm-plate is small and lip-like. Two very short, blunt arm-spines, placed low on the outer edge of the side arm-plate. Color in alcohol, pale straw.

A smaller specimen, with a disk of 2 mm., showed no special variations, except that the radial shields were relatively larger and there were only six primary plates, which is doubtless the normal number.

* ὄφις, a snake : μαστός, a breast.

Station 164, 950 fathoms, 1 specimen. Station 165, 2600 fathoms, 1 specimen. Station 166, 275 fathoms, 1 specimen. Station 218, 1070 fathoms, 2 specimens.

OPHIOPLINTHUS * gen. nov.

Disk smooth and covered by a thin skin bearing irregular delicate scales and radial shields. Genital scales wide and divided in several pieces. Small, blunt, close-set mouth-papillæ ; no tooth-papillæ ; short angular teeth ; very minute, peg-like arm-spines on outer edges of side arm-plates. Second pair of mouth-tentacles and first two pairs of arm-tentacles rising from round pores near the inner end of the under arm-plates ; those beyond are smaller, and stand close to the under arm-spine. Arms narrow, cylindrical, and gradually tapering. Two genital openings, running only a part of the way toward the margin. Mouth-frames seen from above, after removing the top of the disk, long and rising in a ridge, so that in the interbrachial space is a wide angle, and in the brachial space a deep trough. Arm-bones long and cylindrical, with only a faint upper furrow. Genital scales long, slender, and cylindrical.

This genus by its large first under arm-plate has a slight relation to *Ophioglypha*, and by its large tentacle-pores at base of arm, an appearance like *Ophiomusium*, but its structure is really quite peculiar.

Ophioplinthus medusa sp. nov.

Plate II. Figs. 30, 31, 40.

Special Marks. — Scaling of lower interbrachial space coarse (four or five scales in a transverse row). No scales on arm-tentacles. Usually three very minute, peg-like arm-spines, equally spaced.

Description of an Individual (Station 156). — Diameter of disk 16 mm. Width of arm 2 mm. Mouth-papillæ short, square, closely soldered, four or five on each side, with one, diamond-shaped, at apex of the jaw. Mouth-shields rounded triangular, with an angle inward, sides curved, and often a re-entering curve without ; they are frequently furrowed or cracked. Side mouth-shields irregularly rhomboidal, sometimes broader within, where they touch. First under arm-plate rounded triangular, with a blunt angle inward, and a long curved outer edge ; second plate five-sided, with an obtuse angle within, and a curved outer edge ; beyond this they are broader than long, with a blunt angle within and a wavy curve without. Side arm-plates thick and smooth, meeting broadly below and touching above beyond the sixth plate. Upper arm-plates rounded diamond-shaped, with a longer angle within ; they often are cracked or grooved. Disk high, covered with thin, irregular, overlapping plates ; the central primary one about 2 mm. in diameter and conspicuously the largest, and in each brachial space is a primary plate larger than the rest. Radial shields irregular, four-sided, with rounded corners, broader on the outer edge,

* ὄφις, snake ; πλίνθος, tile.

separated their entire length by a broad wedge of small scales. On the under surface of the disk are numerous irregular plates between the genital scales, which are thick, with a wavy outline. The genital opening runs less than half-way to the margin. Three very short, blunt arm-spines, situated low on the outer edge of the side arm-plate. A pair of small tentacle-pores, each surrounded by a raised burr, situated near the inner angle of the second under arm-plate, on its edge; and a similar but minute pair on the third plate. Beyond this the pores are difficult to see and lie near the base of the under arm-spine. The second pair of mouth-tentacles protrude from an oval rim, having on each side a couple of ill-defined tentacle-scales. Color in alcohol, gray.

The disk and arms had clinging to them small polyp-like creatures, about 2 mm. high, and which seemed unquestionably the *Scyphostoma* stage of some medusa, like *Cyanea.* It is not easy to guess what they were doing 12,000 feet below the surface of the ocean.

Station 156, 1975 fathoms, 11 specimens.

Ophioplinthus grisea sp. nov.

Plate II. Figs. 33, 34.

Special Marks. — Scaling of lower interbrachial space fine (ten or twelve in a transverse row). Very small, bead-like scales on first two pairs of arm-tentacles. Two or three very minute, peg-like arm-spines, situated low down.

Description of an Individual (Station 156). — Diameter of disk 20 mm. Width of arm close to disk, without spines, 2 mm. Mouth-papillæ short, thick, closely soldered together, about six on each side, with two longer blunt papillæ at apex of jaw. Mouth-shields small, very broad heart-shape, with a peak within, often cracked in two or more pieces. Side mouth-shields small, narrow, not meeting within, and so covered by the skin as to be seen with difficulty. First under arm-plate large, three-sided, with inner angle much rounded and outer edge slightly curved; second and third pentagonal, with sharp angle inward, lateral sides re-enteringly curved, outer edge slightly rounded; those beyond are rounded diamond-shape, and much broader than long. Side arm-plates smooth, meeting broadly below, slightly swollen along their outer edge. The basal upper arm-plates are as wide as long, of a general oval form, wider without than within, and having a deep median groove. Disk covered with thin, rounded, irregular plates and scales, having six large rounded primary plates, one in the centre and one to each brachial space. Radial shields very irregular, rudely triangular or quadrangular, with rounded corners, separated their entire length by three or more rows of disk-scales; length to breadth 3 : 3. On the under surface of the disk the scales are small and very thin; the genital scales are long and narrow, with an irregular wavy outline and often broken in three pieces. The genital opening extends less than half-way to the margin. The minute blunt arm-spines, of which the under one is largest, stand low, on the side arm-plate. The second pair of mouth-tentacles issue from large

pores, surrounded by a rim of minute, ill-defined papillæ ; the tentacles of the second and third under arm-plates issue in like manner from smaller pores ; beyond this the small tentacle issues near the base of the under arm-spine, and is covered, except at base of arm, by a very small, spine-like scale. The skin of the disk and base of arms is thick, and obscures the finer lines. Color in alcohol, gray.

Station 156, 1975 fathoms, 5 specimens.

OPHIOMUSIUM.

TABLE OF KNOWN SPECIES.

Arms rather slender and tapering; cylindrical, or but slightly wavy from the gentle swelling of the side arm-plates. Upper and under arm-plates persisting nearly to end of arm; but no tentacles beyond third or fourth under plate. Mouth-shields small. Genital opening bounded by small close-set papillæ.	Disk-scales numerous and rather flat, with a large one on the margin. Two or three short stout arm-spines. Side mouth-shields long and large.	*O. eburneum* Lym.
	Interbrachial space between radial shields occupied by two large plates. Papillæ along genital openings extending upward as a small arm-comb. Four or five small arm-spines.	*O. serratum.*
	Papillæ on genital openings extending upward as a small arm-comb. Side mouth-shields small and short. Upper arm-plates comparatively large, some of the basal ones inclining to hexagonal. Three or four small arm-spines.	*O. armigerum.*
	Disk thick. Side mouth-shields and under arm-plates much swollen. Outer mouth-papillæ much larger than inner. Genital papillæ large and bead-like. Six or seven small arm-spines.	*O. corticosum.*
	Disk flat, covered with small imbricated scales, which are nearly equal, except the marginal, which are larger. Upper arm-plates large, the basal ones long hexagonal.	*O. cancellatum.*
	Disk covered by thick skin; its upper surface occupied chiefly (and in half-grown specimens almost entirely) by radial shields and large primary plates, with small scales between. Arms even and cylindrical. Four minute rudimentary arm-spines.	*O. archaster* Wyv. Thom. MS.
Several flat angular plates in lower interbrachial space besides the large one joining the mouth-shield. Genital scales wide. No under arm-plates beyond the second or third.		*O. Lymani* Wyv. Thom.
Upper disk covered by large swollen radial shields, with minute imbricated scaling in centre. Arms wide and thick, with side arm-plates much swollen and rounded. Upper arm-plates broad diamond-shape.		*O. laqueatum.*
Disk covered by large angular swollen plates, of which the interbrachial marginal is largest. Arms wide and thick, with side arm-plates much swollen and rounded, and bearing a spine on their upper surface.	Upper disk-plates bearing large tubercles.	*O. acuferum* Lym.
	Upper disk-plates smooth.	*O. Lütkeni.*
Most of the lower interbrachial space outside the mouth-shield is occupied by broad genital scales and a great central plate. No under arm-plates beyond the third.	Four small, equally spaced arm-spines. Small upper arm-plates. The great lower interbrachial plate has usually two much smaller at its outer corners.	*O. validum* Ljn.
	Two minute arm-spines set low down. Besides the great interbrachial plate below, there are three others along the margin.	*O. simplex.*
	Two minute arm-spines set back from edge of plate. Only one lower interbrachial plate. No upper arm-plates.	*O. lunare.*
	Three short, stout, well-defined arm-spines. Disk-plates thick, separated by narrow grooves, and arranged above like steps. Side arm-plates flaring a little outward.	*O. scalare.*
	Two or three minute arm-spines. Disk-plates coarse, swollen, and irregular. Two or three marginal plates besides the central one in the lower interbrachial space.	*O. testudo* Lym.
	Five short, sharp, well-marked arm-spines. The great lower interbrachial plate is separated by a square one from the mouth-shield. Margin of disk set with small points.	*O. granosum.*
Basal side arm-plates very flat and wide, encroaching much on the interbrachial space, and bearing stout spines on their outer edge. First under arm-plate similar to those beyond, and furnished with a tentacle-scale.	Genital scales meeting on median line of lower interbrachial space.	*O. pulchellum* Wyv. Thom.
	First side arm-plates meeting in median line of lower interbrachial space.	*O. flabellum.*

Ophiomusium serratum sp. nov.

Plate I. Figs. 23, 24, 25.

Special Marks. — Arms rather slender and tapering, cylindrical or but slightly wavy. Upper and under arm-plates persisting nearly to end of arm, but no tentacles beyond third or fourth under plate. Genital opening bounded by small close-set papillæ. Interbrachial space between radial shields occupied by two large plates. Papillæ along genital openings extending upward as a small arm-comb. Four or five small arm-spines.

Description of an Individual (Station 23). — Diameter of disk 10 mm. Width of arm near disk, without spines, 2.5 mm. Mouth-papillæ six on each side, with one at angle of jaw, all in close contact. Mouth-shields heart or rounded-diamond shape, with an angle inward; length to breadth 1.5 : 1. Side mouth-shields long triangular, extending farther out than the mouth-shield; wider without than within, where they just meet. The first four under arm-plates bearing tentacle-scales are pentagonal, with an obtuse angle inward, outer edge slightly curved, lateral sides re-enteringly curved; length to breadth, second arm-plate, 1. : .7. Side arm-plates thick, constricted within, meeting below, even within the disk, and above beyond the second upper arm-plate; those beyond are also pentagonal, but small, broad, and widely separated. Upper arm-plates triangular, with an acute angle inward, and outer edge curved; length to breadth 1 : .7. Disk covered with flat plates closely soldered; in the central space within the radial shields are six rounded primary plates, separated by a circular row of small ones; the interbrachial space is occupied by two angular plates, the outer one much larger. Radial shields long triangular, separated their entire length by one small and two large scales. In the interbrachial space below are two large circular plates, extending from the mouth-shield to margin of disk, on either side of which are smaller circular scales. Genital scales long and very narrow, extending from the edge of the mouth-shield to margin of disk, on the free edge of which are fine tooth-like papillæ, corresponding to similar papillæ along the side mouth-shields, giving a resemblance to *Ophioglypha.* At the base of the arm above are short blunt papillæ on either side of first upper arm-plate. Arm-spines four or five, delicate, pointed, nearly equally placed; middle one longest and nearly half as long as a side arm-plate. A single circular tentacle-scale on second, third, and fourth under arm-plates, situated near the inner angle. The entire surface of the animal is microscopically tuberculated. Color in alcohol, white.

Station 23, 450 fathoms, 1 specimen.

Ophiomusium armigerum sp. nov.

Plate I. Figs. 21, 22.

Special Marks. — Arms rather slender and tapering, cylindrical or but slightly wavy. Upper and under arm-plates persisting nearly to end of arm,

but no tentacles beyond third or fourth under plate. Genital opening bounded by small close-set papillæ, which extend upward as a small arm-comb. Side mouth-shields small and short. Upper arm-plates comparatively large, some of the basal ones inclining to hexagonal. Three or four small arm-spines.

Description of an Individual (Station 332). — Diameter of disk 11 mm. Length of arm 47 mm. Width of arm near the disk 2.5 mm. Mouth-papillæ six on each side, forming a close line, and one larger one at apex of jaw. Mouth-frames long triangular, quite large. Mouth-shields rounded triangular, with an angle inward; length to breadth 1.5 : 1.5. Side mouth-shields short triangular, touching by their narrow ends within. First under arm-plate circular, very small; the next three are furnished with tentacle-scales, and are three-sided, with an angle inward, and outer side curved; the others are smaller and roughly triangular, with an angle inward, and lateral sides curved. Side arm-plates thick, and meeting broadly below beyond the disk, but just touching above on the basal joints. Upper arm-plates long, diamond-shaped, except at base of arm, where the outer and inner angles are truncated. Genital scales very narrow, and so closely soldered to surrounding parts as to be hardly distinguishable. Near inner end of genital opening they bear a few square close-set papillæ, as in *Ophioglypha*. Interbrachial space below covered by ten or a dozen circular plates of irregular outline. Upper surface of disk covered by long, rudely triangular, somewhat sunken radial shields, widely separated their entire length by two or three large and several minute rounded plates; the interbrachial space covered by a large circular marginal plate, with various smaller ones within; the central space within the radial shields by six rounded, sunken primary plates, separated by about three rows of small scales. The entire surface is microscopically tuberculous. Three or four small cylindrical arm-spines, situated well up on the outer edge of the side arm-plate; they stand out from the arm, and the two middle ones are largest. The second, third, and fourth under arm-plates have, near their inner end, small oval tentacle-scales, one to each pore. Color in alcohol, white.

Station 83, 1650 fathoms, 2 specimens. Station 106, 1850 fathoms, 5 specimens. Station 299, 2160 fathoms, (same species?) 1 specimen. Station 332, 2200 fathoms, 1 specimen.

Ophiomusium corticosum sp. nov.

Plate I. Figs. 19, 20.

Special Marks. — Arms rather slender and tapering, cylindrical or but slightly wavy. Upper and under arm-plates persisting nearly to end of arm, but no tentacles beyond third or fourth under plate. Genital opening bounded by small close-set papillæ. Disk thick. Side mouth-shields and under arm-plates much swollen. Outer mouth-papillæ much larger than inner. Genital papillæ large and bead-like. Six or seven small arm-spines.

Description of an Individual (Station 224). — Diameter of disk 12 mm.

Width of arm, without spines, close to disk 2 mm. Mouth-papillæ seven on each side, three basal ones considerably largest; all forming a close line. Mouth-shields small, triangular, with acute angle inward, and outer edge much rounded. Side mouth-shields large, much longer than broad, wider without, meeting within; length to breadth 1.7 : 1. Under arm-plates from the second to the fourth or fifth furnished with tentacles; they are axe-shaped, with an angle inward, lateral sides re-enteringly curved and outer side curved; beyond, the plates are rudimentary and diamond-shaped. Side arm-plates thick, meeting above and below beyond the disk. Upper arm-plates diamond-shaped, with an angle without and within; length to breadth .7 : .7. Genital scales long and narrow, bearing a row of papillæ on the free edge. Lower interbrachial space covered by thin curved plates, of which five form a transverse row along the disk margin; upper surface of disk pentagonal. Radial shields triangular, separated their entire length by a row of small plates; and there is a similar row in each interbrachial space; the central space within the radial shields is covered by six circular primary plates separated by small ones. Arm-spines six or seven in number, very short and blunt, situated on the outer edge of the side arm-plate. No scales beyond the fourth or fifth under arm-plate: they are large, oval, and situated near the inner angle of the plate, one to each pore. Color in alcohol, gray.

Station 224, 1850 fathoms, 3 specimens.

Ophiomusium cancellatum sp. nov.

Plate I. Figs. 17, 18.

Special Marks. — Arms rather slender and tapering, cylindrical or but slightly wavy. Upper and under arm-plates persisting nearly to end of arm, but no tentacles beyond third or fourth under plate. Genital openings bounded by small close-set papillæ. Disk flat, covered with small imbricated scales, which are nearly equal, except the marginal, which are larger. Upper arm-plates large; the basal ones long hexagonal.

Description of an Individual (Station 236). — Diameter of disk 8.5 mm. Width of arm, without spines, 1.5 mm. Length of arm 28 mm. Mouth-papillæ forming a close line, six on each side, with one, diamond-shaped, at angle of jaw. Mouth-shields triangular, with an angle inward, sides equal and curved; length to breadth 1 : 1. Side mouth-shields long triangular; much wider without than within, where they do not quite meet. Genital scales concealed under fine, closely set disk-scales. Under arm-plates pentagonal near base of arm, farther out quadrangular, with an angle inward; one tentacle-scale, which is round, and situated on inner angle of the second and third under arm-plates. Side arm-plates thick, minutely tuberculous, meeting below, but not above, near base of arm. Upper arm-plates near base of arm hexagonal, with outer and inner sides very short. Disk covered above and below by thin, rounded, minutely tuberculous scales; on the margin are larger

angular plates of the same character. Radial shields small, minutely tuberculous, rounded triangular; length to breadth 1.5 : .7; widely separated by a group of half a dozen plates, of which the outer ones are much wider than long. Two or three minute peg-like arm-spines situated in a notch low on the side arm-plate. Color in alcohol, pale gray.

Station 236, 420–470 fathoms, 1 specimen. Station 33, 300 fathoms, (same species?) 1 specimen.

Ophiomusium archaster Wyv. Thom. MS. sp. nov.

Plate II. Figs. 28, 29, 32.

Special Marks. — Arms rather slender and tapering, cylindrical, or but slightly wavy. Upper and under arm-plates persisting nearly to end of arm, but no tentacles beyond third or fourth under plate. Genital opening bounded by small close-set papillæ. Disk covered by thick skin, its upper surface occupied chiefly (and in half-grown specimens almost entirely) by radial shields and large primary plates, with small scales between. Arms even and cylindrical. Four minute rudimentary arm-spines.

Description of an Individual (Station 323). — Diameter of disk 10 mm. Width of arm close to disk, without spines, 2.5 mm. Five mouth-papillæ on each side, short, pointed, closely joined, with one large, diamond-shaped, at angle of jaw. Mouth-shields broad heart-shaped, with a peak within; length to breadth 1.3 : 1.5. Side mouth-shields long triangular, very broad without; tapering and curved inward, where they meet. First under arm-plate very small, triangular, with angle inward; the three next bear tentacle-scales, and are three-sided, with lateral sides a little re-enteringly curved and outer side slightly curved; the rest are small, triangular, with outer side curved. Side arm-plates thick, slightly swollen, somewhat constricted within, meeting below throughout, and above beyond the third upper arm-plate. First two upper arm-plates rounded and much wider than those beyond, which are triangular, with an angle inward, lateral sides straight, outer edge much curved. Disk flat, covered with thick, minutely tuberculous plates and scales. Radial shields sunken, of irregular rhomboidal shape, with corners rounded; length to breadth 1.7 : 1.3. Central primary plate smaller than the others, circular, sunken, separated by a double row of small circular scales from five large sunken, nearly round plates which surround it; the rest of the upper surface is covered with small rounded scales, with a larger one on the margin. Under surface covered with small rounded plates, irregularly disposed; genital scales long and very narrow, on the free edge of which are fine, short, square papillæ, corresponding to similar ones on the side arm-plates. One small rounded tentacle-scale, situated near inner angle of plate. Three or four minute, slender, rounded arm-spines standing low down on arm-plate; upper one longest. Color in alcohol, straw.

Station 323, 1900 fathoms, 5 specimens.

Ophiomusium Lymani Wyv. Thom.

Ophiomusium Lymani, Depths of the Sea, p. 172, Figs. 32, 33. 1873.

The specimens from the following widely separated stations showed certain minor differences. For example, those from Station 235 had more arm-spines and rather more numerous lower disk-plates, and the tentacle-scales were entire, instead of divided. I have deemed it best to keep the varieties together for the present.

Station 45, 1245 fathoms, 1 specimen. Station 50, 1250 fathoms, 12 specimens. Station 76, 900 fathoms, 1 specimen. Off Tristan d'Acunha, 1100 fathoms, 7 specimens. Station 169, 700 fathoms, 1 specimen. Station 191, 800 fathoms, 4 specimens. Station 235, 565 fathoms, 5 specimens. Station 296, 1825 fathoms, (only arms.)

Ophiomusium laqueatum sp. nov.

Plate I. Figs. 14-16.

Special Marks. — Upper disk covered by large swollen radial shields, with minute imbricated scaling in centre, arms wide and thick, with side arm-plates much swollen and rounded. Upper arm-plates broad, diamond-shape.

Description of an Individual (Station 192). — Diameter of disk 14 mm. Width of arm 3.5 mm. Mouth-papillæ six or seven on each side, and one, diamond-shaped, at angle of jaw. Mouth-shields ovoid, slightly pointed within; length to breadth 2 : 1.3. Side mouth-shields long, narrow, having curved sides, wider without than within, where they nearly or quite meet; length 2.3 mm. Genital scales very long and narrow, extending from mouth-shield to margin of disk, and bearing on their free edge an irregular row of close-set oblong papillæ. Under arm-plates triangular, with an angle inward; in the first two plates the angle is blunt, becoming more acute in those beyond; outer edge somewhat curved. Tentacle-scales only on the first three plates; they are minute, circular, two in number, set close together and situated very near the inner angle. Side arm-plates thick, swollen, barely meeting above and below at the inner angle of the upper and under arm-plates. Upper arm-plates near base of arm quadrangular, wider than long; length to breadth 1.3 : 2; towards end of arm they are three-sided. Disk covered in centre with fine delicate scales, among which appear six larger rounded primary plates, which are widely separated, one in the centre, and one in each brachial space. Radial shields oval, swollen, a little wider without than within, separated from each other their entire length by two or three long oval scales mingled with finer. Interbrachial spaces on upper surface occupied by two or three rounded scales, bordered by smaller, and of which the largest is on the margin of disk. Under interbrachial space covered by about a dozen thick, rounded, swollen scales, almost concealing the genital scale; the three largest stand on or near the margin. Four minute peg-shaped arm-spines; three standing together, low on the edge of the plate; the fourth placed much above them. Color in alcohol, white.

Station 192, 129 fathoms, 1 specimen.

Ophiomusium Lütkeni sp. nov.

Plate V. Figs. 138-140.

Special Marks. — Disk covered by large, angular, smooth, swollen plates, of which the interbrachial marginal is largest. Arms wide and thick, with side arm-plates much swollen and rounded, and bearing a spine on their upper surface.

Description of an Individual (Station 192). — Diameter of disk 13 mm. Length of arm about 45 mm. Width of arm close to disk, without spines, 2.5 mm. Four or five large square mouth-papillæ on each side, with one, small and slender, at apex of jaw, all closely joined, those without being deeper than those within. Mouth-shields rudely three-sided, having a blunt angle within and a curved outer edge broken by angles. Length to breadth 2.5 : 2.7. Side mouth-shields longer than broad, and thick, meeting well within, where they are slightly narrower than without. First under arm-plate small, nearly square, with all four angles rounded ; the next two larger, pentagonal, with an angle inward, outer lateral corners rounded, and deep re-entering curves on the lateral sides, where the tentacle-scales stand ; the under arm-plates beyond these are minute and triangular, having an angle inward and the outer edge slightly curved. Side arm-plates large, swelling without into a rounded ridge and forming the greater part of the covering of the arm. Upper arm-plates triangular, with an angle inward, and all three sides slightly curved. Disk massive and flat, covered with thick, slightly swollen plates, one pentagonal primary in the centre, surrounded by five rudely hexagonal plates ; interbrachial spaces filled by one hexagonal plate within, and a smaller quadrangular extending to the very large marginal plate, which is much swollen and has a constriction on the outer edge. Radial shields large and angular, wider without than within, with outer angles rounded, separated their entire length within by an hour-glass-shaped wedge of three small plates. Lower interbrachial space covered by the great marginal plate, the broad genital scales extending from the mouth-shield to the marginal plate, and by three intermediate plates. There are two short blunt arm-spines, besides a supplementary spine on the top of the side arm-plate. Tentacle-pores at the second and third under arm-plates only, with one small round scale on each pore. Color in alcohol, grayish.

By its general shape, and by the extra spines on top of the arm, this species approaches *O. acuferum*, but is distinguished by form and arrangement of disk-plates.

Station 192, 129 fathoms, 3 specimens.

Ophiomusium validum Ljn.

Ophiomusium validum Dr. Goës, Vestindisk. Oph. Öf. Kong. Akad. p. 618. 1871.

Plate I. Figs. 7-9.

Special Marks. — Most of the lower interbrachial space outside the mouth-shield is occupied by broad genital scales and a great central plate. No under

arm-plates beyond the third. Four small, equally spaced arm-spines. Small upper arm-plates. The great lower interbrachial plate has usually two much smaller at its outer corners.

Description of an Individual (Station 24). — Diameter of disk 8.5 mm. Width of arm, without spines, close to disk 2 mm. Mouth-papillæ five on each side, with a large diamond-shaped one at angle of jaw, all forming a close line. Mouth-shields large, irregularly pentagonal, with an acute angle inward and outer edge straight; length to breadth 2 : 1.7. Side mouth-shields longer than broad, wider without than within; outer ends curved, touching by their narrow ends within. Genital scales large, semicircular, stretching from mouth-shield to margin of disk. There are only three under arm-plates, the first small and diamond-shaped, lying at outer end of mouth-slit; second and third pentagonal, with an angle inward, and lateral and outer sides nearly straight. Side arm-plates thick, slightly swollen, and beyond the third under arm-plate forming the entire covering of the arm, with the exception of rudimentary triangular upper arm-plates, which do not extend to the tip of the arm. Disk rather flat, and covered by closely soldered plates; the upper surface is occupied by six primary plates, separated by many smaller ones; radial shields rounded triangular, with acute angle within; outer edges curved, strongly diverging inward, and separated by a triangular scale. In interbrachial space are two angular plates, the outer one wide quadrangular and closely soldered to a great marginal plate, which, with the genital scales, covers the interbrachial space on the under surface of the disk. At base of arm above are four little plates, two central and two lateral. Four short, blunt, and thick arm-spines, situated low on the outer edge of the side arm-plate. Tentacle-scales minute, rounded, situated on the inner angle of second and third under arm-plates. Color in alcohol, pale gray.

In presence of the many new species of *Ophiomusium*, it has been thought well to give figures and a full description of this one.

Station 24, off St. Thomas, 390 fathoms, 2 specimens. Station 23, close to Sombrero, 450 fathoms, 3 specimens.

Ophiomusium simplex sp. nov.

Plate I. Figs. 10, 11.

Special Marks. — Most of the lower interbrachial space outside the mouth-shield is occupied by broad genital scales and a great central plate. No under arm-plates beyond the third. Two minute arm-spines set low down. Besides the great interbrachial plate below there are three others along the margin.

Description of an Individual (Amboyna). — Diameter of disk 6 mm. Width of arm without spines 1.5 mm.; length of arm 15 mm. Mouth-papillæ seven on each side, and one, spearhead-shaped, at angle of jaw, closely soldered together and forming a slightly raised continuous line. Mouth-shields little longer than broad, pentagonal, with acute angle within, at the corners of

which begin the genital openings ; outer side straight. Side mouth-shields short, wide, with curved sides meeting within ; length 1 mm. Genital scales large, semicircular, somewhat swollen, running from lateral corners of mouth-shield to margin of disk. There are only two under arm-plates besides the small semicircular one at the angle of the mouth-slit ; they are pentagonal, with an angle inward ; lateral and inner lateral sides straight ; outer side slightly curved. Tentacle-scales on second and third plates small, circular, and situated at the inner corners. Side arm-plates swollen, forming the entire covering of the arm beyond the last under arm-plate, with the exception of minute upper arm-plates, which are triangular, with an angle within. Disk covered with closely soldered plates ; in the centre of the upper surface is a pentagonal plate, surrounded by five rudely hexagonal, which are connected with the radial shields by plates somewhat longer than broad, between each pair of which are large angular scales. Radial shields shaped like a rounded pear-seed, much swollen, touching at their middle point, but diverging outward and inward, separated on either side of the point of contact by a small triangular scale ; on the interbrachial disk-margin is an angular, much swollen plate, joining three of similar character, which, with the genital scales, cover the under surface of the interbrachial space ; at the base of the arm above are three small rounded scales. Arm-spines two, minute, blunt, and set low down on the edge of the side arm-plate. Color in alcohol, white.

Amboyna, 100 fathoms, 1 specimen.

Ophiomusium lunare sp. nov.

Plate I. Figs. 4-6.

Special Marks. — Most of the lower interbrachial space outside the mouth-shield is occupied by broad genital scales and a great central plate. No under arm-plates beyond the third. Two minute arm-spines set back from edge of side arm-plate. Only one lower interbrachial plate. No upper arm-plates beyond second.

Description of an Individual (Station 219). — Diameter of disk 7 mm. Width of arm, without spines, close to disk 1.5 mm. Length of arm about 20 mm. Mouth-papillæ seven on each side, with one, somewhat larger than the rest, at the angle of the jaw. Mouth-shields large, pentagonal, with an acute angle within, and outer side straight ; length to breadth 1.5 : 1. Side mouth-shields large, long triangular ; sides slightly curved, with narrow ends touching within. Genital scales long, with interbrachial side curved, starting at the inner corner of the genital opening and touching the radial shields with their outer ends. Under arm-plates pentagonal, with an angle inward, and outer side slightly curved ; there are only two besides the small one at the outer end of mouth-slit. Side arm-plates thick, composing the entire covering of the arm, with the exception of the minute triangular upper arm-plate, which has an angle inward, and outer side curved, and disappears on the second or third

joint. The disk is rather flat, covered with microscopically tuberculated plates, well soldered together; the margin is occupied by one large plate, touching the radial shields on either side, and extending below to the mouth-shields; the centre is occupied by six primary plates, one pentagonal, surrounded by five rudely hexagonal. The radial shields are pear-seed shape, and large, having a blunt angle inward, and outer edge much rounded; they touch only at their middle point, and are separated within and without by a small triangular scale. The interbrachial space below is covered by the large marginal plate, already mentioned, and the stout genital scales. Tentacle-scales minute, circular, situated at the inner corners of the second and third plates. Two very small, short, and blunt arm-spines. Color in alcohol, white.

Station 219, depth 150 fathoms, 1 specimen.

Ophiomusium scalare sp. nov.

Plate I. Figs. 1-3.

Special Marks. — Most of the lower interbrachial space, outside the mouth-shield, is occupied by broad genital scales and a great central plate. No under arm-plates beyond the third. Three short, stout, well-defined arm-spines. Disk-plates thick, separated by narrow grooves, and arranged above like steps. Side arm-plates flaring a little outward.

Description of an Individual (Station 171). — Diameter of disk 5 mm. Width of arm without spines 1 mm. Length of arm about 10 mm. Mouth-papillæ three on each side, and one at angle of jaw, closely soldered together, forming high continuous ridges, radiating from the mouth. Mouth-shields five-sided, having a long acute angle within, and the outer side straight; length to breadth 1 : 1. Side mouth-shields long, narrow, meeting within; broader without than within, where they join the first side arm-plate; length 1 mm. Genital scales large semicircular, somewhat swollen. Under arm-plates minute, three in number; the first one semicircular, wedged between the side mouth-shields; second and third longer than wide, with acute angle inward, lateral sides straight, and outer side slightly curved. Tentacle-scales round, very small, situated near inner angle of the under arm-plate. Side arm-plates thick, swollen, covering almost the entire arm beyond the disk. Upper arm-plates minute, diamond-shaped. Under surface of disk covered, in the interbrachial spaces, by genital scales, and three large swollen semicircular plates, whose outer edge is curved; upper surface of disk covered with small tuberculous plates, forming a much raised rosette, the central plate of which is pentagonal, the primary plates surrounding it semicircular. Radial shields closely soldered together, and partly separated by an angular plate. In the interbrachial spaces are two large plates, radiating from the central rosette, one five-sided, with an acute angle inward, and joined to the inner edge of the radial shields; the other, which is on the margin of the disk, is a large, nearly square, corrugated plate, and is attached on either side to small oval plates,

which form above the base of the arm two irregular transverse rows, three or four in each row. Three small peg-like arm-spines about one third as long as a joint. Color in alcohol, pale gray.

Station 171, 600 fathoms, 1 specimen.

Ophiomusium granosum sp. nov.

Plate I. Figs. 12, 13.

Special Marks. — Most of the lower interbrachial space outside the mouth-shield is occupied by broad genital scales and a great central plate. No under arm-plates beyond the third. Five short, sharp, well-marked arm-spines. The great lower interbrachial plate is separated by a square one from the mouth-shield. Margin of disk set with small points.

Description of an Individual (Station 237). — Diameter of disk 10 mm. Width of arm, without spines, close to disk 2 mm. Mouth-papillæ very closely soldered together, forming a ridge. Mouth-shields triangular, with an acute angle within, and the outer edge curved. They bear minute spines. Side mouth-shields long and narrow; meeting within, where they are narrowest. Genital scales large, angular, longer than wide. First under arm-plate semicircular; second and third triangular, with an acute angle inward. Side arm-plates minutely tuberculous, meeting broadly above and below, and nearly covering the entire arm beyond the disk. Upper arm-plates minute, triangular, with acute angle inward. There are no tentacle-scales. Disk covered with closely soldered plates, having decided furrows between them; the microscopic tuberculation usual in the genus is very coarse, and rises near edge of disk into small points. The margin is occupied by a large, angular, swollen plate, covered with points, which connects the radial shields with the genital scales, and is united to the mouth-shield by a smaller rectangular plate, also carrying points. Radial shields pear-seed shape, diverging inward, where they are separated by a triangular plate. In centre of upper surface of disk is a large pentagonal primary plate, surrounded by five others, quadrangular, and connected with the radial shields by five rudely triangular pieces; in each interbrachial space above are two quadrangular plates, besides that of the margin. Arm-spines five in number, occupying the whole edge of the side arm-plates; they are short, rounded, and delicately tapering. Color in alcohol, gray.

Station 237, 875 fathoms, 4 specimens.

Ophiomusium pulchellum Wyv. Thom.

Voyage of the "Challenger." The Atlantic, Vol. II. p. 67, Figs. 18, 19.

Plate V. Figs. 144, 145.

Special Marks. — Primary plates bearing a large central tubercle; second pair of side arm-plates wide, and flaring below; lower interbrachial space occupied almost wholly by large genital scales, and a marginal plate like a tubercle.

Description of an Individual * (Station 122). — Diameter of disk 4.5 mm. Length of arm about 7 mm. Width of arm close to disk, without spines, 1 mm. Mouth-papillæ closely soldered, forming a straight line on the sides, with one round, bluntly pointed papilla at apex of the jaw. Mouth-shields small, triangular, with a long angle within, outer edge much rounded ; length to breadth, .5 : .5. Side mouth-shields large, long, and narrow, meeting within, wider without than within, with outer ends rounded. First under arm-plate of a rude wedge-shape, having the outer edge widest, and curved, long lateral sides slightly re-enteringly curved, and a short blunt angle within ; second, third, and fourth plates broader than long, much broader without than within, lateral sides with deep re-entering curve, and outer side strongly curved ; fifth plate triangular, and much smaller ; beyond which the plates are diamond-shape and minute. Side arm-plates wide and swollen, meeting broadly above and below, beyond the sixth under arm-plate forming almost the entire covering of arm ; the second pair are very wide below, flattened and flaring, and form a part of the disk margin. Upper arm-plates small, broader than long, with outer edge gently and inner edge deeply curved ; growing rapidly smaller, and almost disappearing beyond the sixth. Disk thick and round, covered with swollen, microscopically tuberculous plates ; in the centre are six primary plates, forming a regular rosette, the central one pentagonal, the others hexagonal, and each bearing a large tubercle ; in the interbrachial space there is one large square plate, also bearing a tubercle ; outside this is a large, much swollen marginal plate, which is much wider without than within, the inner edge being straight and the outer re-enteringly curved. Radial shields large, rudely oval, longer than broad, joined for nearly their whole length ; overlapped on their inner ends by one of the primary plates, and separated without by a small, much swollen, semicircular plate ; length to breadth 1 : .7. On the lower interbrachial space there are two minute plates, just outside the mouth-shield ; then the two great genital scales, which occupy most of the space, and meet within at the mouth-shield, and are separated without by a large thick plate, wedged between them, which extends outward beyond the margin, in form of a tubercle. The first side arm-plate carries two short, thick, blunt arm-spines ; the second, which forms part of the margin of the disk, has three spines ; the rest have two, all situated low on the outer edge. One large, rounded tentacle-scale on the inner side of each tentacle-pore of the first five under arm-plates. Color in alcohol, white.

By its curious, flaring under arm-plates at the base of the arm, and its short, rapidly tapering arm, this species gets a fanciful resemblance to some of the star-fishes. It is an aberrant species, yet is correctly included by Sir Wyville Thomson under *Ophiomusium*. Its distribution is wide, and embraces the South Atlantic, including the Cape of Good Hope ; and in depth from 150 to 1675 fathoms.

Station 87. 1675 fathoms (Wyv. Thom.). Station 122, 350 fathoms, 4 specimens. Station 142, 150 fathoms, 3 specimens.

* The description is from a specimen larger than the one figured.

Ophiomusium flabellum sp. nov.

Plate V. Figs. 141-143.

Special Marks. — Basal side arm-plates very flat and wide, encroaching much on the interbrachial space, and bearing stout spines on their outer edge. First under arm-plate similar to those beyond, and furnished with a tentacle-scale. First side arm-plates meeting on median line of lower interbrachial space.

Description of an Individual. — Diameter of disk 3.3 mm. Length of arm 3.3 mm. Width of arm close to disk, without spines, 1 mm. Mouth-papillæ closely soldered together, forming a continuous line. Large triangular mouth-frames. Mouth-shields minute, diamond-shape. Side mouth-shields very large, meeting broadly within, with outer ends wide and much rounded, having a re-entering curve on the lateral edge, where stands the tentacle-scale. First, second, and third under arm-plates pentagonal, with a blunt angle within, outer edge slightly curved, and lateral sides re-enteringly curved ; the second is largest of the three ; the fourth and last is a minute, broad, triangular scale, without a tentacle-pore. The first pair of side arm-plates are swollen, and of such extraordinary size as to meet on the median line of the interbrachial space ; the second are smaller, and meet above and below ; beyond the fourth under arm-plate they form the entire covering of the arm. Only two minute triangular upper arm-plates, having the outer edge slightly curved. Disk high and round, covered with thick, much swollen plates, whereof the middle are somewhat sunken ; the central primary is pentagonal, surrounded by a row of angular plates, of nearly equal size ; outside this row, in each interbrachial space, is another angular plate separating the inner ends of the rather long, closely joined radial shields. On the interbrachial margin is a large, much swollen boss, rising high above the other disk-plates, and connecting the neighboring radial shields. On the interbrachial space of the under surface there is but one minute triangular scale, outside the enormous first pair of side arm-plates ; these carry on their outer edge three small blunt spines, which look like marginal disk-papillæ ; the next pair carry only two spines ; and beyond, there is only one, which is blunt and short, and carried low on the outer edge of the plate. Only three pairs of tentacle-pores (including the mouth-tentacles), each with one large rounded scale on the lateral sides of the under arm-plates. Color in alcohol, very pale brown.

This species and *O. pulchellum*, by their large flat side arm-plates of the first pair, and peculiar first under arm-plate, which bears tentacle-scales, are strongly distinguished from others of the same genus.

Off Port Jackson, 30-35 fathoms, 1 specimen.

OPHIOPYRGUS gen. nov.

Disk high and dome-shaped, covered with thick swollen plates, and surmounted by a central primary plate, which rises like a cone. Arms slender,

smooth, and tubular, with side arm-plates very large, and upper and under arm-plates small. Basal tentacle-pores very large; those beyond small and situated near sides of arm. An arm-comb. Arm-spines minute, and standing on outer edge of side arm-plate. Two long genital openings in each interbrachial space.

This is the most singular-looking genus yet found among *Ophiuridæ*. With its peg-like central primary plate and dome-like disk it suggests a simple armed crinoid whose head has been broken from the stem. By its heavy, closely soldered plates and peculiar tentacle-pores, it recalls *Ophiomusium;* by its enclosed mouth-tentacles and arm-comb, it brings to mind the deep-sea *Ophioglyphæ;* but it differs pretty widely from both.

Ophiopyrgus Wyville Thomsoni sp. nov.

Plate V. Figs. 135 - 137.

Special Marks. — One minute arm-spine on basal joint; farther out, none; a double arm-comb over top of arm, the upper one consisting of three or four small papillæ on edge of outer end of genital scale; the under, likewise of three or four papillæ, on edge of side arm-plate. Interbrachial space below wholly filled by mouth-shield.

Description of an Individual (Station 172). — Diameter of disk, 4 mm. Height of disk 4.3 mm. Length of arm 13 mm. Width of arm 1.2 mm. Mouth-papillæ small, similar, separated, tooth-like; seven or nine to each angle, whereof the innermost is slightly largest. Mouth-shields longer than broad, oval, with a peak inward, occupying the entire interbrachial space below, and bending upwards to half the height of the arm. Side mouth-shields very small and sunken, meeting within, and covering only the inner peak of mouth-shield. First under arm-plate very long axe-shape, with a curved edge outward and a long, tapering point inward, compressed between two large oval tentacle-pores; second plate similar, but smaller; third and fourth plates shorter and still smaller; beyond which the plates are represented by a small knot of a transverse diamond-shape, and growing rapidly less towards end of arm. Side arm-plates large, but not swollen, meeting widely above and below, occupying most of the arm, which acquires thereby a tubular, rapidly tapering form. The side arm-plates belonging to second under plate are wide, and stretch laterally to meet the mouth-shield. Disk as high as wide, rising in a steep dome surmounted by a sugar-loaf projection, which is the central primary plate, and is surrounded by five other primaries, longer than broad, and hexagonal, outside which are small, angular, radial shields, which are joined; in the interbrachial space are one pentagonal and one rounded hexagonal plate, the latter joining the upper edge of the mouth-shield; all the plates are closely soldered, slightly swollen, and, as well as the arm-plates, are microscopically tuberculous. Genital openings long, curved and narrow, extending from inner point of mouth-shield to a point over arm. One minute peg-

like arm-spine, which is found only on the first two or three joints beyond disk, and stands half-way up the side arm-plate. The second pair of mouth-tentacles protrude from very large oval pores covered with four flat rounded scales; the next pores, those of the first arm-tentacles, are similar but smaller; the next still smaller; while those of the fourth under arm-plate are little round holes covered by a single scale. Farther out on arm the pores lie behind and above the rudimentary under arm-plate. Color in alcohol, white.

The large side arm-plates and few disk-plates suggest that this is a young animal. Unfortunately the depth is given as 18 and 240 fathoms; but the character of the animal seems to indicate the latter depth.

Station 172, off Nukualofa, Tongatabu, 18 and 240 fathoms, 2 specimens.

OPHIERNUS* gen. nov.

Central portion of disk inside radial shields covered by a thick skin; round the margin a broad band of scaling, interrupted only by radial shields, and covering also the lower interbrachial space, the whole more or less hidden by the skin. Radial shields naked. Teeth, and small, numerous, close-set mouth-papillæ. First under arm-plate rather large, and bearing some of the scales of the second pair of mouth-tentacles. Upper arm-plates covering the whole width of arm. Small smooth arm-spines, arranged along outer edge of side arm-plate. Two large, long genital openings in each interbrachial space.

In the size and function of the first under arm-plate, and in the size and shape of the upper arm-plates, this genus has a slight relation to *Ophioglypha.*

Ophiernus vallincola sp. nov.

Plate VI. Figs. 170-172.

Special Marks. — Three small cylindrical pointed arm-spines, less than half as long as an arm-joint, set close together and low down on side arm-plate; mouth-shields rounded and widely separated.

Description of an Individual (Station 78). — Diameter of disk 9 mm. Length of arm about 50 mm. Width of arm close to disk, without spines, 1.7 mm. Four small, short, rounded, bead-like mouth-papillæ on either side of the mouth-frames, and usually two at apex under teeth, which are four in number; large and flat, with a rounded cutting edge; besides these there are two little papillæ on the side mouth-shield and two on the first under arm-plate, which may be considered scales of the second pair of mouth-tentacles. Mouth-shields triangular, length to breadth about equal, with blunt angle inward, and outer corners rounded. Side mouth-shields short, broad without, pointed within, lying on lateral sides of mouth-shield, by which they seem widely separated, but the inner narrow points run under the thick skin, and nearly meet

* ὄφις, snake; ἔρνος, sprout.

within. First under arm-plate triangular, with inner angle truncated, lateral sides re-enteringly curved, and outer edge rounded; the rest are narrow and rudely pentagonal, those near base of arm having the inner angle truncated, and the outer slightly curved; inner laterals bounded by a re-entering curve; length to breadth .8 : .8. Side arm-plates broad and flat, not meeting below, separated above by the broad upper arm-plates, which are much wider than long, and cover the whole upper surface of arm, having the lateral sides nearly straight, and edge with a slightly re-entering curve. Disk flat and round; central portion covered with a thin, naked, cross-wrinkled skin; along the margin are minute scattered granules, which, with the thick skin, hide the underlying scales. Radial shields longer than broad, much rounded, widely separated; length to breadth 2 : 1.5. Lower interbrachial space covered with a thin skin, on which there is a very scattered granulation. Genital openings wide, extending from mouth-shield to edge of disk. Genital scale not seen. Three small, tapering, cylindrical arm-spines, less than half as long as an arm-joint, set low on the outer edge of side arm-plate. Two small rounded scales on the interbrachial edge of each tentacle-pore. Color in alcohol, greenish-gray.

This species grows to a large size; one with a disk of 20 mm. was similar to the above, except that the mouth-angle was narrower and more prolonged, and bore, on each side of the mouth-frames, eight small, very close-set papillæ. The granulation of the disk was feeble; in many specimens it is wholly wanting. The pair of small mouth-papillæ under the teeth is often wanting.

Station 78, 1000 fathoms, 2 specimens. Station 146, 1375 fathoms, 12 + specimens. Station 156, 1975 fathoms, 1 specimen.

It is with doubt that the two following species are referred to *Ophioceramis.* They are both rather young, and have perhaps not taken on their full characters. Dr. Lütken pointed out the two divisions of Ophiurans, in one of which the side arm-plates, rising in ridges, bear the spines on their *sides*, standing at right angles to the axis; in the other the same plates are flat, and carry their spines on their *outer edge* parallel with the axis. *Ophiothrix* is an exact type of the first, *Ophiolepis* of the second. But there are genera intermediate, where the base of the spine, not crowded against the side arm-plate, as in *Ophiolepis*, stands on the *outer corner* of the edge, and has a lateral motion as far as a right angle, instead of hugging the arm. *Ophiozona* illustrates this intermediate stage, while the third genus of the *Ophiolepis* group — *Ophioceramis* — may be said to bear its spines almost on the sides of the side arm-plates. As hinted above, *O. obstricta* and *O. clausa* differ in various ways from the type, and are placed here waiting further information.

Ophioceramis (?) clausa.

Plate VI. Figs. 161-163.

Special Marks. — Four arm-spines, the two upper slender and tapering, the two lower stout and blunt. A great marginal scale, which occupies also most of the lower interbrachial space.

Description of an Individual (Station 170). — Diameter of disk 4 mm. Length of arm about 18 mm. Width of arm without spines 1.2 mm. Three short, stout, pointed mouth-papillæ, well separated on each side, with one larger and spearhead-shaped at the apex of angle. Mouth-shields broader than long, transverse diamond-shape, with outer angle indented; length to breadth .6 : 1. Side mouth-shields very large and wide, somewhat longer than wide, square without, meeting broadly within, and there forming a deep angle. First under arm-plate broader than long, rounded; the rest are widely separated, twice as broad as long, with outer edge nearly straight, a very obtuse angle or weak curve within, and a small re-entering curve on the lateral sides. Side arm-plates stout, flaring a little outward where they form the spine-ridge, meeting broadly above and below. Upper arm-plates broader than long, wide fan-shape with an angle inward, somewhat swollen, making the arm high and rounded. Disk round and flat, covered with thin, flat, angular scales arranged symmetrically; central primary plate pentagonal, surrounded by five others rounded hexagonal and somewhat smaller; interbrachial spaces filled by three large scales, the two inner ones four-sided, the outer one rounded and lying on the margin, showing little above, but beneath occupying the whole interbrachial space except two small scales outside the mouth-shield. Radial shields regular, longer than broad, wide without, coming by curved sides to a point within, where they are separated by a small triangular scale, but are joined for the rest of their length; they, as well as the other disk-scales, bear a few microscopic tubercles. Four arm-spines; the two upper thin and tapering, and nearly as long as an arm-joint; the two lower shorter, stouter, and more blunt; towards tip of arm there are three, the upper long and slender, as long as two joints; the second similar, but shorter; and the lowest very stout and somewhat curved. One very small rounded tentacle-scale, on the first two pairs of tentacle-pores; beyond there are two. Color in alcohol, pale brown.

Station 170, 630 fathoms, 1 specimen.

Ophioceramis (?) obstricta sp. nov.

Plate VI. Figs. 164-166.

Special Marks. — Five short, nearly equal, blunt, tapering arm-spines. Radial shields separated in the brachial spaces, but touching in the inter-brachial.

Description of an Individual (Station 192). — Diameter of disk 4 mm.

Length of arm about 12 mm. Width of arm close to disk, without spines, 1.2 mm. Seven small, short, rounded mouth-papillæ to each mouth-angle, the inner one longer and more prominent. Three squarish teeth, the upper one very small. Mouth-shields broader than long, inner angle broad and rounded, lateral corners rounded, and outer edge much curved ; length to breadth .7 : .6. Side mouth-shields large, somewhat swollen, square, and wide without ; tapering slightly inward, where they just meet. First under arm-plate rounded and conspicuous ; the plates beyond are short pentagonal, with an angle inward. Side arm-plates thick and somewhat flaring outward, meeting broadly below and also above beyond the first, which is broader than long, four-sided, with slight re-entering curves on the lateral sides and outer corners rounded ; beyond, the plates are pentagonal, with an obtuse angle inward, and lateral and outer sides straight. Disk thin and sunken, and contracted in the interbrachial spaces, covered with small overlapping plates ; in centre are six rudely angular primaries, separated in the interbrachial spaces by several minute rounded scales. Radial shields large, longer than broad, swollen, raised above the surrounding scales, having a long angle inward and outer angles rounded ; separated their whole length by an inner and outer wedge, each composed of two small quadrangular plates ; length to breadth 1.5 : .8 : each shield touches that of the neighboring pair by its interbrachial edge, and is separated without by a marginal wedge-like scale. Lower interbrachial space with a row of scales on the margin, the central one being larger with edges rounded, its inner edge touching the mouth-shield. Genital scales short and thick, composed of two or three angular pieces. Five short, blunt, tapering arm-spines, about two thirds as long as an arm-joint, extending along the entire edge of the side arm-plate. One pointed tentacle-scale, so minute as to be seen with difficulty. Color in alcohol, pale brown.

Station 192, 129 fathoms, 1 specimen.

OPHIOZONA Lym.

Ophiozona stellata sp. nov.

Plate VI. Figs. 147, 148.

Special Marks. — Two short arm-spines placed low on the plate, the lower one twice as long as the upper. Arm somewhat flattened, side arm-plates not swollen. Radial shields small, irregular, widely separated.

Description of an Individual (Station 168). — Diameter of disk 9 mm. Length of arm about 35 mm. Width of arm close to disk, without spines, 1.8 mm. Four squarish close-set mouth-papillæ on each side, and two longer and more pointed at angle of jaw. Four short stout teeth, the lowest thickened and rounded. Mouth-shields three-sided, with a long angle within, and outer edge much curved ; length to breadth 1.8 : 1.8. Side mouth-shields short and thick, wide without; tapering to a point within, where they just meet. First under arm-plate very small, transverse oval in form ; second plate wider

without than within, four-sided, having lateral sides re-enteringly curved and a peak without ; those beyond are similar, but nearly pentagonal. Side arm-plates broad and thick, meeting below beyond the fourth under arm-plate and above beyond the second upper arm-plate, which is fan-shaped, with an angle inward. Disk flat and rather thin, covered with stout, rounded, microscopically tuberculous plates, whereof a large primary occupies the centre, with five others about it, separated in the interbrachial space by a radiating row of two or more scales ; outside these, again, is a row of ten semicircular plates with small scales between ; near each interbrachial margin are two plates side by side ; on the lower interbrachial space are three transverse rows of irregularly shaped plates. Genital scales composed of three irregular pieces placed end to end. Genital openings extending from outer edge of mouth-shield to margin. Two short, stout, blunt, tapering arm-spines placed low on the side arm-plate, the lower one twice as long as the upper and about half as long as an arm-joint. One large rounded tentacle-scale on the inner side of the tentacle-pore. Color in alcohol, pale gray.

A young with a disk of 2.8 mm. had arms 5 mm. long. The disk was more arched, and its plates, of course fewer, were microscopically tuberculous. The side mouth-shields were very large and swollen, and the mouth-shields small. The first under arm-plate larger than in the adult, and the rest much smaller proportionately.

Station 168, 1100 fathoms, 12 + specimens. Station 169, 700 fathoms, 12 + specimens.

Ophiozona insularia sp. nov.

Plate VI. Figs. 149 - 151.

Special Marks. — Four short, nearly equal arm-spines. Arm high. Side arm-plates swollen, and strongly flaring outward. Radial shields large, rounded triangular, widely separated.

Description of an Individual (Station 173). — Diameter of disk 6 mm. Length of arm about 18 mm. Width of arm close to disk, without spines, 1.6 mm. Five short, squarish, close-set mouth-papillæ on each side, one large spearhead-shaped at apex of angle. Mouth-shield longer than broad, with a very deep curve without, and an angle within ; length to breadth, 1 : .8. Side mouth-shields short and thick ; rather wider without than within, where they meet. First under arm-plate very small, transverse oval in shape ; second, third, and fourth plates large and five-sided, with inner angle truncated, small re-entering curves on the lateral sides, and outer edge slightly curved ; beyond, they approach a fan-shape, with an angle inward. Side arm-plates broad, swollen, and flaring outward, just meeting below beyond the fifth under arm-plate, and above beyond the fifth or sixth arm-plate, which is fan-shaped, with an angle inward. Disk rounded pentagonal and flat, with a large central plate, and five others round it, separated from each other by a wedge-scale ; interbrachial spaces filled by four angular plates, a large one within, outside this

two smaller, and then a squarish marginal plate. Radial shields swollen, longer than wide, three-sided, with angles rounded, separated their entire length by a wedge of three plates, whereof the innermost is largest and connects with a primary plate ; length to breadth 1.3 : 1. Lower interbrachial space covered by two very irregular transverse rows of long rounded plates. Genital scales long and narrow, curved and tapering. Four short blunt arm-spines, the three lowest longest, and about half as long as an arm-joint. Two tentacle-scales on the first two pairs of tentacle-pores, a small one within and larger one without ; beyond this there is only one large round scale. Color in alcohol, white.

A smaller specimen, whose diameter of disk was 3.5 mm., was similar, except that the disk-plates were fewer and more regular, and the radial shields were scarcely separated.

Station 173, off Matuka, Fiji Islands, 310 fathoms, 3 specimens.

Ophiozona antillarum sp. nov.

Plate VI. Figs. 152, 154.

Special Marks. — Two short arm-spines, upper one longer. Arm of medium height. Side arm-plates somewhat flaring outward. Radial shields large, pointed without and within, nearly joined at their middle point.

Description of an Individual (Station 23). — Diameter of disk 8 mm. Width of arm, without spines, close to disk 1.8 mm. Four short, rounded, close-set mouth-papillæ on each side, and two longer and sharper at apex of angle. Mouth-shields as long as broad, with an angle within, bounded by re-entering curves, and outer edge much rounded ; length to breadth 1.5 : 1.3. Side mouth-shields short and thick, wide without, meeting broadly within. First under arm-plate small, pointed, transverse oval in shape ; second plate large pentagonal, with inner angle truncated, lateral sides having a short but deep re-entering curve, and outer edge neatly curved ; the plates beyond have a long sharp angle within, and very short lateral sides. Side arm-plates wide, and somewhat swollen, and flaring outward, meeting below beyond the fourth under arm-plate, and above beyond the first upper plate, which is much swollen and narrow fan-shaped, with an angle inward. Disk round, flat, and rather thin ; in centre a rosette of six large, irregular, rounded primary plates, the five outer ones separated from each other by pairs of small, thick, angular scales. In the interbrachial spaces are numerous small, and three large plates in a radiating line, two long hexagonal and one larger and rounded on the margin. Radial shields somewhat sunken, longer than wide, with irregularly curved outlines, and a blunt angle within and without, separated at their inner end by a large hexagonal plate, and without by a small triangular plate. Lower interbrachial space filled by three transverse rows of irregular plates. Genital scales long and narrow, and composed of several pieces. Two short, stout,

blunt-pointed arm-spines, the upper one longer, and two thirds as long as an arm-joint. One large round tentacle-scale on each pore. Color in alcohol, white.

Station 23, 450 fathoms, 1 specimen.

Ophiozona depressa sp. nov.

Plate VI. Figs. 155 - 157.

Special Marks. — Two nearly equal short arm-spines. Arm low. Side arm-plates slightly flaring without. Radial shields large, oval, and widely separated.

Description of an Individual (Station 214). — Diameter of disk 11 mm. Length of arm about 37 mm. Width of arm close to disk, without spines, 1.8 mm. Four short, squarish, close-set mouth-papillæ on each side, the outer one very small, and a pair somewhat more pointed at apex of angle. Mouth-shields longer than broad, with a sharp angle within, and outer side bounded by a deep curve ; length to breadth 2 : 1.7. Side mouth-shields short, broad without, tapering inward, where they meet in a point. First under arm-plate very small, transverse pointed oval ; next two plates long pentagonal, with a truncated angle within, deep re-entering curve on each inner lateral corner, and a curved outer edge ; beyond these the plates are short pentagonal. Side arm-plates low (the arm being flat), little swollen, slightly flaring outward, meeting below beyond the fifth under arm-plate, and above beyond the second upper plate, which is fan-shaped, with an angle within. Disk round and flat ; in the centre is a large pentagonal primary plate, round which are five others, smaller and more or less rounded, separated from each other by a triangular scale. These primary plates have a little central boss or tubercle ; in the interbrachial spaces is a radiating row of three large elongated plates, the outer and longest being marginal. Radial shields flat, longer than broad, oval, separated their entire length by two large plates ; length to breadth 2.5 : 1.7 mm. Lower interbrachial space filled by irregular transverse rows of uneven plates, the outer row long and angular. Genital scales long, narrow, and broken in several pieces. Genital opening not extending to margin of disk. Two short, blunt, tapering arm-spines of equal length, and about half as long as an arm-joint. One large rounded tentacle-scale on the inner side of each tentacle-pore. Color in alcohol, white.

Station 214, 500 fathoms, 3 specimens.

Ophiozona nivea Lym.

Ophiozona nivea, Ill. Catal. Mus. Comp. Zoöl. VIII. No. 2, p. 9, Figs. 85, 86. 1875.

Station 24, off St. Thomas, 390 fathoms, 1 specimen.

OPHIOTROCHUS * gen. nov.

Disk flat and round, covered with thin, more or less granulated scales, and naked radial shields. Arms slender, tubular, each joint constricted at its base; side arm-plates meeting widely above and below; upper arm-plates rudimentary. Scale of second pair of mouth-tentacles lying between side mouth-shield and outer mouth-papillæ. There are teeth and mouth-papillæ; no tooth-papillæ. Smooth arm-spines on outer edges of side arm-plates.

Ophiotrochus panniculus sp. nov.

Plate VI. Figs. 158-160.

Special Marks. — First arm-joint, outside of disk, much wider than those beyond, and bearing four slender spines; the others having only two. A sparse granulation on the lower interbrachial space.

Description of an Individual (Station 218). — Diameter of disk 6 mm. Length of arm 26 mm. Width of arm without spines .8 mm. Two wide, very short, close-set mouth-papillæ, occupying the whole of each side of an angle; and at the apex three more, very small, short, and spiniform. Mouth-shields three-sided, with a long angle inward, and outer corners slightly rounded; length to breadth 1.3 : 1. Side mouth-shields much longer than broad, swelled without like a knob, long and very narrow within, where they nearly or quite meet; they usually bear a few grains. First under arm-plate small and rounded, with a slight peak inward; the rest are somewhat broader than long, pentagonal, with an angle inward, the outer edge rounded, and re-entering curves on the lateral sides. Side arm-plates making together a tubular figure, flaring outward, meeting broadly below and above. Upper arm-plates very minute, and almost disappearing towards middle of arm, situated at the outer junction of the side arm-plates, three-sided, and with a peak within. Disk flat and round, covered with thin delicate scales; six rounded primary plates, separated by a line of scales, may be distinguished in the centre; the rest are more or less angular, and irregularly disposed. Radial shields broader than long, of irregular shape, with rounded angles, narrowly separated by a single line of scales. Interbrachial space below covered with thin scales sparsely set with small grains, which stand also on the margin. Two large genital openings, extending from the outer corners of mouth-shield to margin of disk. On first joint, outside disk, four sharp slender arm-spines, placed high on side arm-plate, the uppermost one as long as an arm-joint, the others progressively shorter; on joints beyond there are only two short spines. One large rounded tentacle-scale on the inner edge of each tentacle-pore; the second pair of mouth-tentacles have a wide flap-like scale hinged on the side mouth-shield,

* ὄφις, snake; τροχός, wheel.

and enclosed by the wide outer mouth-papillæ. Color in alcohol, very light gray.

Other specimens had the disk-scales more regularly disposed than in Fig. 159, and the radial shields pear-seed shape with an angle inward.

Station 218, 1070 fathoms, 12 + specimens.

OPHIOPHYLLUM* gen. nov.

Disk extremely thin and flat, covered with scales and large radial shields, and bordered by a row of plates which are movable and attached by their inner margins. Mouth-papillæ arranged in a close row ; no tooth-papillæ ; teeth. Arm-spines thin and broad, standing on outer edge of side arm-plate. Two genital openings in each interbrachial space.

This singular genus has small relationship with any other. The fringe of thin plates is like that found in *Podophora* among echinoderms.

Ophiophyllum petilum sp. nov.

Plate VII. Figs. 179-181.

Special Marks. — Fringe-like border of disk consisting of about a dozen very thin plates in each interbrachial space. One arm-spine, which is wide and flat like a plate of the border. No tentacle-scale.

Description of an Individual (Station 174). — Diameter of disk 6 mm. Width of arm, without spines, close to the disk 1.2 mm. Six small, short, square, close-set mouth-papillæ on either side of an angle, and three smaller diamond-shaped at the apex. Mouth-shields rather large fan-shaped, with a deep curve without and an angle within ; length to breadth 1 : 1.2. Side mouth-shields narrow, bounding the inner angle of the mouth-shield ; outer ends square, inner ends tapering and separated. First under arm-plate three-sided, with a rounded angle inward, lateral sides straight, and outer edge curved ; the rest are small and pentagonal, with an angle inward. Side arm-plates broad and thin, meeting below beyond the second under arm-plate, and just touching above beyond the third upper arm-plate. Midway of the arm, where it is highly arched, they form most of its covering. Basal upper arm-plates diamond-shaped ; those beyond become more or less triangular, with a sharp angle inward, and outer edge slightly rounded. Disk flat and very thin, the centre covered with fine, thin, irregular scales ; interbrachial space on margin filled by one large three-sided plate, with an angle inward and outer edge nearly straight. Radial shields large, three-sided, longer than wide, with outer angles slightly rounded, separated their entire length by a cluster of irregular scales larger than those of the centre ; in the lower interbrachial

* ὄφις, snake ; φύλλον, leaf.

space are two regular transverse rows of long and narrow plates. Genital scales small, much longer than wide, extending from the outer corners of the mouth-shield to the disk margin. On the margin of the disk there is a fringe-like border of long, thin, rounded scales attached only by their inner margins, about twelve to each interbrachial space. Only one arm-spine, which is attached to lower edge of side arm-plate, and is a broad rounded scale like those on the marginal border. No tentacle-scales. Color in alcohol, pale brown.

Station 171, 600 fathoms, 1 specimen (young). Station 174, 210 – 600 fathoms, 1 specimen.

OPHIOBYRSA* gen. nov.

Entire animal clothed in a thick skin, which hides the underlying plates, and is beset on the disk with spines. Arm nearly cylindrical. Side arm-plates projecting as short flap-like spine-ridges, which bear slightly rough spines on their outer edge. Tentacles large and simple. Few or no mouth-papillæ, but at apex of mouth-angle the teeth and tooth-papillæ are represented by a clump of little spines. Two large genital openings in each interbrachial space.

Ophiobyrsa rudis sp. nov.

Plate VIII. Figs. 198 - 200.

Special Marks. — Disk closely covered with short spines. Arms very long, tapering, and nearly cylindrical. Six short arm-spines.

Description of an Individual (Station 161). — Diameter of disk 28 mm. Length of arm 300 mm. Width of arm without spines 3.5 mm. One small, short, delicately pointed mouth-papilla on each side of the mouth-angle, and at the apex a clump of short, sharp, spine-like papillæ, which occupy the place of teeth. Mouth-shields obscured by thick skin ; only their rounded outline may be distinguished. Side mouth-shields and upper arm-plates entirely concealed by thick skin. Side arm-plates project to form a thin, short, flap-like spine-ridge. On the upper surface of the arm there are two longitudinal rows of very short, stout spines arranged in pairs, and usually standing on tubercles. Disk five-sided and rather thin, covered by a thick skin, which is closely and evenly beset above and below with short, stout, smooth, sharp spines or thorns ; they are somewhat longer and more numerous near the margin of the interbrachial spaces, and are almost wanting just over the base of each arm. Six equal, short, blunt, flat, somewhat rough arm-spines, partly covered by skin, not so long as an arm-joint, and placed on the edge of side arm-plates. Tentacles large, simple, and round. No tentacle-scales. Color in alcohol, disk yellowish brown ; arms the same, but much lighter.

Station 161, 38 fathoms, 2 specimens.

* ὄφις, snake ; βύρσα, skin.

OPHIOCHITON * gen. nov.

Disk covered with fine, imbricated scales and small radial shields. Numerous sharp mouth-papillæ, with teeth but no tooth-papillæ. Upper and under arm-plates about as broad as long, and separating the side arm-plates, which project slightly and are rather small. Under plates furnished with a median longitudinal ridge. Arm-spines slender and smooth, arranged on the sides of the side arm-plates, near the outer edge. Two long genital openings in each interbrachial space.

The genus is allied to the true *Ophiarachna*, which, however, has a granulated disk.

Ophiochiton fastigatus sp. nov.

Plate VII. Figs. 182, 183.

Special Marks. — Four slender, smooth, tapering, blunt arm-spines. Scaling of disk very fine, with a few larger rounded plates. Radial shields small and separated. About thirteen mouth-papillæ to each angle.

Description of an Individual (Station 232). — Diameter of disk 20 mm. Width of arm, without spines, close to the disk 2.8 mm. Five or six sharp pointed papillæ on each side of an angle, and one shorter and more rounded at the apex. Mouth-shields much broader than long, with lateral corners rounded, a peak within and a lobe without; length to breadth 2.3 : 3. Side mouth-shields very narrow, broader without than within, where they meet. First under arm-plate very small, triangular; the other plates are four-sided, with outer and inner edges nearly straight, and deep re-entering curves on the lateral sides: they are highly arched, forming along the arm a longitudinal ridge. Side arm-plates small, with a rather low spine-ridge, not meeting below or above. Upper arm-plates broader than long, slightly arched, four-sided, broader without than within; inner and lateral sides straight, outer edge slightly curved. Disk flat, with interbrachial spaces somewhat contracted, covered above and below by very minute, thin, overlapping scales; three to five in the length of a mm. and somewhat larger near margin. In each brachial space there is a row of small rounded scattered plates, radiating from the central primary plate; genital scales covered. Radial shields widely separated, long triangular, and small, with an angle within; length to breadth 2 : 1. Four smooth, tapering, blunt, nearly cylindrical arm-spines, placed high on the sides of side arm-plates near the outer edge; lengths to that of an arm-joint 1.8, 1.8, 1.8, 2 : 1.3. Two tentacle-scales on each pore, one large one on the interbrachial and a smaller one on the brachial side. Color in alcohol, pale brown; upper disk inclining to olive.

A smaller specimen with a disk of 13 mm. had arm 70 mm. long. It was similar to the adult, except that there usually were but three arm-spines, and

* ὄφις, snake; χιτών, coat of mail.

the second and third mouth-papillæ from corner of mouth-slit were flat and blunt.

Station 232, 340 fathoms, 6 specimens.

OPHIOPYREN * gen. nov.

Disk granulated. Teeth; no tooth-papillæ; numerous mouth-papillæ arranged in a close line. Mouth-frames long and conspicuous. Side mouth-shields small † and widely separated by the mouth-shield. Under arm-plates divided in two parts by a crease or joint. Arm-spines standing on outer edge of side arm-plates. Two genital openings in each interbrachial space.

Ophiopyren stands nearest *Pectinura*, from which it is distinguished by the divided under arm-plates and the tendency to minute grain-like papillæ along the genital opening. The peculiar division of the under arm-plates by a crease or soldered joint rises in this way; near the tip of the arm the *inner* piece of the plate occupies most of the space, under form of a long narrow plate having a sharp angle without, where are the tentacle-pores bordered by a narrow rim, and this rim, growing gradually wider and thicker, forms the outer piece as it appears near the base of the arm.

Ophiopyren brevispinus sp. nov.

Plate VII. Figs. 173-175.

Special Marks. — Three very short, blunt arm-spines. Mouth-shields longer than broad, pentagonal.

Description of an Individual (Station 173). — Diameter of disk 3.8 mm. Width of arm without spines 1 mm. Thirteen or fourteen mouth-papillæ to each angle, of which the outer one on each side is much the largest, and the rest are short and square, except the one at the apex, which is more pointed. Mouth-shields longer than broad, pentagonal, with long pointed angle within; length to breadth .8 : .5. Side mouth-shields squarish and very short, widely separated by inner angle of mouth-shield. First under arm-plate much broader than long, of an irregular oval form; second plate as long as broad, pentagonal, with a blunt angle inward; third plate similar, but with a sharper angle within; those beyond grow proportionately longer, and become gradually wedge-shape, with a truncated angle inward. Each plate is apparently divided in two parts, the inner one more or less diamond-shaped, the outer made up of the remainder of the plate. Upper arm-plates four-sided, somewhat wider without than within, lateral sides straight, outer side slightly curved. Side arm-plates not swollen, meeting neither above nor below. Disk flat and round,

* ὄφις, a snake; πυρήν, a kernel.

† Their strict homology with the side arm-plates is very plain in this genus, especially in *O. longispinus*.

covered above and below with minute granules, about a dozen in the length of a mm. In lower interbrachial space on the side mouth-shield next the genital opening are three minute grain-like papillæ. Radial shields small, partially covered by granulation, closely joined, much rounded within ; just outside them is a row of large granules. Genital opening long, extending from side of mouth-shield to edge of disk ; genital scale hidden by granulation. Two short round tentacle-scales on the second under arm-plate ; beyond, only one. Three very short, blunt, pointed arm-spines, arranged evenly along the outer edge of the side arm-plate. Color in alcohol, white.

Station 173, off Matuka Bay, Fiji, 300 fathoms, 1 specimen.

Ophiopyren longispinus sp. nov.

Plate VII. Figs. 176 - 178.

Special Marks. — Three slender arm-spines, as long as an arm-joint. Mouth-shields wide heart-shape, broader than long.

Description of an Individual * (Station 33). — Diameter of disk 4.5 mm. Width of arm, without spines, close to disk 1 mm. Fifteen or sixteen mouth-papillæ to each angle, of which the outer one, on either side, stands on the side mouth-shield, is larger than and separated from the others, and is sharp and curved ; the rest are small, squarish, and close, except the one at the apex, which is sharp and longer. Mouth-shields broader than long, three-sided, outer edge straight, lateral corners much rounded, and an angle inward ; length to breadth .8 : 1. Side mouth-shields squarish and large, widely separated by mouth-shields, similar in form and position to the side arm-plates beyond. First under arm-plate small triangular, with an acute angle inward, and outer edge slightly curved ; second plate four-sided, wider without than within ; third plate as long as broad, much wider without than within, having outer corners rounded. All the plates are apparently composed of two pieces, — an inner, which has a sharp angle outward, and an outer, which comprises the rest of the plate. Side arm-plates broad, not swollen, meeting neither above nor below. Upper arm-plates wider without than within, considerably arched, and with outer corners prolonged in small peaks. Disk round and thick, covered above and below with very minute granulation, 15 or 20 grains in the length of a mm. Radial shields small, of a rounded pear-seed shape, nearly or quite joined, and to be seen only when the granulation has been removed. Genital openings extending from outer edge of mouth-shield to margin of disk. Genital scales hidden by the skin and granulation. On the interbrachial edge of the side mouth-shields are four short rounded papillæ. Three long, very delicate, pointed arm-spines, the middle one a little the longest, upper and under spine of about the same size, and about as long as an arm-joint. One long pointed tentacle-scale on each of the first pair of tentacle-pores ; beyond there are two,

* The description is from a specimen larger than the one figured.

one large and rounded, and one smaller and narrower. Color in alcohol, white.

A smaller specimen (Station 24) was more evenly granulated, and the radial shields were quite hidden. The upper arm-plates were so thin as to show the arm-bones through.

Station 24, 390 fathoms, 3 specimens. Station 33, off Bermuda, 300 fathoms, 1 specimen.

The following four genera are allied. *Ophiacantha* is distinguished by the delicate scales and slender radial shields obscured by skin ; *Ophiothamnus*, by its wide naked radial shields, and by the peculiar jaw-cover of three symmetrical pieces ; *Ophiomitra* by the coarse disk-plates and scales, and wide naked radial shields ; and *Ophiocamax* by the tufts of numerous spiniform mouth and tooth-papillæ, and the scales of the mouth-tentacles borne on a special plate. The old genus *Ophiacantha* embraces the greatest variety of forms, from *O. bidentata* and *O. vivipara*, which come near *Ophiocoma*, to the delicate *O. pentacrinus*, with its thorny, translucent arm-spines and its knotted arms.

OPHIACANTHA Müll and Trosch.

Disk covered by small delicate scales, and long narrow radial shields, the whole nearly or quite obscured by a skin beset with little thorns or stumps. Teeth and mouth-papillæ, but no tooth-papillæ. Numerous arm-spines (5 – 9), arranged along sides of side arm-plates, which are prominent, and nearly or quite meet above and below. In each interbrachial space two genital openings, beginning just outside the mouth-shield.

OPHIOTHAMNUS Lym.

Disk beset with fine thorns or spines, and covered by rather large scales and naked radial shields. Teeth, and stout, close-set mouth-papillæ, but no tooth-papillæ. Numerous (8) thorny translucent arm-spines, arranged along sides of side arm-plates, which are prominent, and nearly or quite meet above and below. In each interbrachial space two genital openings, beginning close outside the mouth-shield. The jaw-cover is in three pieces, arranged symmetrically like the mouth-shield and side mouth-shields.

OPHIOMITRA Lym.

Disk covered by large, irregular plates and scales, and wide naked radial shields, the whole naked and beset by thorny stumps or spines. Teeth, and mouth-papillæ, but no tooth-papillæ. Numerous (5 – 7) thorny translucent arm-spines, arranged along sides of side arm-plates, which are prominent, and nearly or quite meet above and below. In each interbrachial space two genital openings, beginning close outside the mouth-shield.

OPHIOCAMAX * gen. nov.

Disk beset with thorny spines or stumps, and covered by scales or irregular plates and large radial shields. Besides teeth, there are tooth-papillæ and mouth-papillæ, numerous, and all of the same spine-shape ; they are arranged in tufts on the mouth-frames and jaw-plate. The spiniform scales of the mouth-tentacles are borne on the edge of a little supplementary plate in a way similar to *Ophioglypha*. Numerous (9) thorny translucent arm-spines, arranged along the sides of the side arm-plates, which are prominent, and meet nearly or quite above and below. In each interbrachial space two genital openings, which begin close outside the mouth-shield.

OPHIACANTHA.

TABLE OF SPECIES HEREIN DESCRIBED.

Disk closely beset with grains or minute tubercles. Arm-spines smooth.	Four arm-spines. Disk minutely tuberculous.	*O. tuberculosa.*
	Seven slender translucent arm-spines. Some smooth spines on disk.	*O. vepratica.*
	Ten arm-spines. Outer ends of radial shields naked.	*O. granulosa.*
Disk closely beset with short, smooth, stout spines, sometimes mingled with grains. Eleven thorny arm-spines. Radial shields covered.		*O. rosea.*
Disk beset with small short stumps, or grains, bearing a crown of blunt thorns. Six arm-spines, stout, opaque, and scarcely thorny. Slender tentacle-scales.		*O. imago.*
Disk beset with short slender spines.	Disk-spines with forked heads, and covered with thick skin. Arm-spines scarcely or not at all thorny. One minute short tentacle-scale.	*O. sentosa.*
	Disk-spines simple. Arm-spines not thorny. One or two large long tentacle-scales	*O. stimulea.*
	Spines of disk and arms slender and translucent. Arm-spines not thorny. Some thorny stumps on disk.	*O. segesta.*
Disk beset with stout spines ; arms essentially smooth, and about twelve times diameter of disk. Radial shields partly naked, and making narrow radiating ridges.		*O. Troscheli.*
About eleven mouth-papillæ to each angle. Large tentacle-scales		*O. cuspidata.*
Seven mouth-papillæ to each angle. Slender spiniform tentacle-scales		*O. longidens.*
Seven mouth-papillæ. High disk-stumps, with thorny sides and ends. Arm-spines feebly thorny. Six arms.		*O. nodosa.*
The lowest arm-spine thickened and curved		*O. cornuta.*
Eight or more feebly thorny arm-spines. Side arm-plates very prominent. Disk-crochets rather stout.		*O. cosmica.*
Arm-spines very long, not thorny. Side arm-plates large and swollen. Outer side of under arm-plates strongly curved		*O. levispina.*
Disk beset with minute grain-like stumps, bearing a crown of blunt thorns. Arm-spines long, slender, translucent, thorny ; mounted on very projecting side arm-plates, which meet above.		*O. serrata.*

* ὄφις, snake ; κάμαξ, stake.

Ophiacantha tuberculosa sp. nov.

Plate VIII. Figs. 204, 205.

Special Marks. — Disk wrinkled and beset with coarse grains ; four smooth stout arm-spines.

Description of an Individual (Station 210). — Diameter of disk 6.5 mm. Length of arm 32 mm. Width of arm without spines 2 mm. Seven stout blunt mouth-papillæ, whereof the innermost is spearhead-shaped and stands under the teeth, which are four in number, flat and square, with rounded corners. Mouth-shields small, much wider than long, with an obtuse angle within and a little peak without ; length to breadth .8 : 1. Side mouth-shields short, nearly crescent-shape, with the curve outward ; scarcely meeting within. Under arm-plates thick and distinct, four-sided, somewhat broader than long, with outer side curved and the others nearly straight, except second plate, which is nearly pentagonal, with a very obtuse angle within. Side arm-plates slightly projecting, meeting narrowly below and not at all above. Upper arm-plates thick and well marked, four-sided, with outer corners rounded, much wider without than within. Disk contracted in interbrachial spaces, with deep radiating furrows between the narrow radial shields, which are completely hidden, as well as the disk-scales, by the skin and by numerous small conical tubercles, which are larger and closer set on the radial shields. Four stout, blunt, cylindrical, smooth arm-spines ; upper one much largest ; lengths to that of an arm-joint 2, 1.4, 1, 1 : 1. One rather small tentacle-scale, longer than wide, pointed, and not encroaching (as is usual in the genus) on the under arm-plate. Color in alcohol, very pale brown.

This species is one of the most aberrant in the genus ; the arm-spines, smooth and only four in number, and the minute disk-tubercles, instead of thorny grains, remind one rather of *Ophiocoma*. Indeed, *Ophiacantha bidentata* and *O. vivipara*, which somewhat resemble this species, have been described under *Ophiocoma ;* but the general structure is that of a true *Ophiacantha*.

Station 210, 375 fathoms, 1 specimen.

Ophiacantha vepratica sp. nov.

Plate X. Figs. 245-247.

Special Marks. — Disk closely beset with grains, among which are a few short spines. Seven not thorny, translucent, slender arm-spines.

Description of an Individual (Station 171). — Diameter of disk 6.5 mm. Length of arm about 30 mm. Width of arm without spines 1.8 mm. Mouth-papillæ stout, conical, blunt, three on each side of an angle, and a larger odd one at the apex within, which is similar to the five teeth standing immediately above it. Mouth-shields small, about as long as broad, bounded within by an obtuse angle, and without by a deep curve or truncated angle ; length to

breadth .8 : 1. Side mouth-shields short and rather wide, meeting within. Under arm-plates pentagonal, wider than long, with a very obtuse angle inward, sometimes modified as a curve ; lateral sides a little re-enteringly curved, and outer side gently curved. Upper arm-plates wide fan-shaped, with an angle inward. Side arm-plates stout, rather prominent, narrowly meeting above and below, near base of arm. Disk slightly puffed and wrinkled, closely set with small, round, smooth grains, among which, on upper surface, appear a few short stout spines ; radial shields and disk-scales hidden by skin and by granulation. Seven regular, slender, cylindrical, tapering, not thorny arm-spines ; lengths to that of an arm-joint 2.8, 2.5, 2, 2, 1.5, 1.3, 1 : .8. One pointed, rather large tentacle-scale. Color in alcohol, white.

A smaller specimen had a disk 6 mm. in diameter with grains, but scarcely any spines on it. A young one had a disk 4 mm. in diameter, and arms 16 mm. long. The disk-grains were rough under the microscope ; the arm-spines were proportionately longer, and the side arm-plates more prominent, than in the adult ; the outer mouth-papilla was larger than its neighbors.

Station 171, 600 fathoms, 2 and 2 young specimens.

Ophiacantha granulosa sp. nov.

Plate VIII. Figs. 206-208.

Special Marks. — Disk evenly set with smooth grains ; outer ends of radial shields naked ; ten smooth slender arm-spines.

Description of an Individual (Station 201). — Diameter of disk 9 mm. Length of arm 42 mm. Width of arm without spines 3 mm. Seven pointed, rather stout, nearly cylindrical mouth-papillæ. Seven teeth, flat, with a rounded cutting edge. Mouth-shields small, broader than long, with an obtuse angle within, and a curve without ; length to breadth .8 : 1. Side mouth-shields large and wide, broader without than within, where they are slightly separated. Under arm-plates much wider than long, of a wide axe-shape, with a curved edge outward, a lobe or a narrow obtuse angle within, and the lateral sides re-enteringly curved. Upper arm-plates rather small, of a wide fan-shape, with an angle inward, and lateral sides re-enteringly curved. Side arm-plates large and moderately projecting, meeting broadly above, near base of arm, but scarcely touching below. Disk slightly puffed, closely and evenly set with smooth grains, about four in the length of a mm., which hide the fine disk-scales, except in the lower interbrachial spaces. Radial shields covered, except their outer ends, which are naked and sunken below the surrounding surface. Ten slender, tapering, cylindrical, translucent arm-spines, which are not thorny ; lengths to that of an arm-joint 3.2, 3.2, 2.2, 2, 2, 2, 1.8, 1.3, 1.3, 1 : 1. One rather small, blunt tentacle-scale. Color in alcohol, pale reddish-brown.

A younger specimen, with a disk 4 mm. in diameter and an arm of 18 mm., presented no special variations, except that there were only eight arm-spines, and the under arm-plates were proportionately smaller.

Station 201, 82-102 fathoms, 8 specimens.

Ophiacantha rosea sp. nov.

Plate X. Figs. 267, 268.

Special Marks. — Disk-scales and radial shields hidden by a thick skin, which is closely beset with very short, stout spines, which sometimes are no higher than grains. Eleven arm-spines, slightly rough under microscope.

Description of an Individual (Station 308). —Diameter of disk 17 mm. Length of arm, 68 mm. Width of arms without spines 4.5 mm. Mouth-papillæ irregular ; there are usually five on the inner part of the angle, flattened and blunt ; and outside these, near end of mouth-slit, a group of from three to six irregular papillæ, short and flattened. Eight or nine teeth, shaped like blunt spear-heads. Mouth-shields and side mouth-shields closely joined and covered with thick skin, so that their outlines are not clear. Under arm-plates shield-shaped, with an angle within, a curve without, and re-entering curves on the lateral sides opposite the large tentacle-scales. Upper arm-plates with distinct outlines, broad fan-shaped, with a rounded or very obtuse angle inward. Side arm-plates, near base of arm, barely meeting above and below, and having a narrow projecting spine-ridge. Disk puffed, densely and evenly beset, with very short, stout, conical spines, which to the naked eye seem nearly like large grains ; scales and radial shields entirely covered. Eleven stout, blunt, 'regular, cylindrical arm-spines, which, under the microscope, are slightly rough. Lengths to that of an arm-joint 3.5, 4.7, 4, 3.8, 3.8, 2.8, 2.5, 2.5, 2.5, 1.2. .8 : 1.3. One very large, thick, pointed tentacle-scale, over 1 mm. long. Color in alcohol, pale rose-pink above ; below yellowish.

Specimen from the distant station 145 differed only in having larger spines on the disk. A young one, with a disk of 7 mm. had onlv seven mouth-papillæ to each angle ; the additional papillæ at the outer end of mouth-slit had not yet appeared ; the disk-spines were forked and thorny, and the eight arm-spines were rough and almost thorny.

Station 145, 310 fathoms, 8 specimens. Station 308, 175 fathoms, 12 + specimens. Station 236, 420 – 775 fathoms, 1 specimen.

Ophiacantha imago sp. nov.

Plate X. Figs. 275, 276.

Special Marks. — Disk regularly set with small, short, thick stumps, each bearing a crown of blunt thorns ; tentacle-scales small and pointed ; six short, opaque, cylindrical, scarcely thorny arm-spines.

Description of an Individual (Kerguelen Islands). — Diameter of disk 8 mm. Length of arm 37 mm. Width of arm without spines 1.6 mm. Seven short, stout, blunt, close-set mouth-papillæ; the innermost are a little the largest. Four flat, rather thick teeth, all squarish, except uppermost one, which is pointed. Mouth-shields small, of a rounded diamond-shape. Side mouth-shields short, wide, slightly curved, not meeting within. They and the mouth-

shield are obscured by a thick skin. Under arm-plates somewhat obscured by skin, axe-shaped, with a broad curve without, a narrow angle within, and lateral sides slightly re-enteringly curved. Upper arm-plates long triangular, with an acute angle inward and a curve without. Side arm-plates large, meeting above and below, with a rounded, rather wide, but not very prominent spine-ridge. Disk regularly, but not very closely set with small, short, thick stumps (Fig. 276), each bearing a crown of blunt thorns. Radial shields and scaling hidden. Six cylindrical, opaque, blunt, slightly tapering arm-spines, which, under the microscope, are a little rough, but not thorny ; lengths to that of an under arm-plate 3, 2.2, 1.3, 1.2, 1.2, 1 : 1. One minute pointed tentacle-scale. A young specimen from the same locality had a disk 4 mm. in diameter, and arms of 18 mm. The disk-stumps were closer set, and more like grains, and there were nine mouth-papillæ to each angle.

This species is viviparous. It represents in the antarctic zone the arctic *O. anomala*, from which it differs in having a minute slender tentacle-scale and only five arms.

Christmas Harbor, Kerguelen Islands, 120 fathoms, 1 specimen. Royal Sound, Kerguelen Islands, 25 fathoms, 1 specimen. Station 150, 150 fathoms, 6 specimens. Station 151, 75 fathoms, 1 specimen.

Ophiacantha sentosa sp. nov.

Plate IX. Figs. 229-232.

Special Marks. — Disk closely beset with short slender spines, with forked heads, encased in thick skin, so that they give the disk a furry look ; arm-spines slender and not thorny ; one minute rounded tentacle-scale.

Description of an Individual (Station 298). — Diameter of disk 16 mm. Length of arm 80 mm. Width of arm without spines 3 mm. Mouth-papillæ nine or eleven, to each angle of which the innermost odd one is stoutest and spearhead-shaped, and is similar to and continuous with the teeth ; the outermost is very small and rounded, and the others are stout, conical, and pointed. Mouth-shields small, wider than long ; bounded within by an obtuse angle, and without by a curve. Side mouth-shields wider without than within, where they meet, of moderate width, and extending well beyond mouth-shield on either side. Under arm-plates slightly swollen, much wider without, where they are gently curved, than within, where they present a peak, and are separated from the next plate ; lateral sides re-enteringly curved opposite tentacle-pores. Side arm-plates moderately prominent, meeting below, and beyond fourth joint, above also. Upper arm-plates about as long as broad, narrow fan-shaped, with an angle inward. Disk puffed, covered with a thick skin, which obscures the radial shields and scaling, except a patch near mouth-shield ; the surface is closely set with small spines, about .8 mm. long, whose ends are forked, but which are more or less cased in skin. Seven regular tapering arm-spines, smooth, or bearing a few

minute thorns ; the upper one somewhat longer ; lengths to that of an arm-joint 4, 3, 2.8, 1.6, 1.6, 1.6 : 1.2. One small, blunt, pointed tentacle-scale. Color in alcohol, disk above dull chocolate-brown, lower side and arms pale brown.

The only essential variation noted was in a larger specimen, with a disk of 18 mm., which had sometimes as few as seven mouth-papillæ to an angle.

Station 298, 2225 fathoms, 4 specimens.

Ophiacantha stimulea sp. nov.

Plate IX. Figs. 225-228.

Special Marks. — Disk closely set with small simple spines. Arm-spines not thorny. One or two large long tentacle-scales.

Description of an Individual (Station 164). — Diameter of disk 7 mm. Length of arm 35 mm. Width of arm without spines 2 mm. Ten or twelve pointed, flat, rather thin mouth-papillæ, of which the two innermost are largest, the others about equal. Teeth similar to innermost mouth-papillæ, but larger. Mouth-shields wider than long, rather small, bounded without by a curve and within by an obtuse angle. Side mouth-shields somewhat curved, rather narrow within, where they meet, wide without. Under arm-plates wider without, where they are bounded by a gentle curve, than within, where they present an obtuse angle ; lateral sides slightly re-enteringly curved. Upper arm-plates fan-shaped, with an angle inward. Side arm-plates stout and prominent, meeting narrowly above and below, near base of arm. Disk a little puffed, with a constriction in each interbrachial margin, closely set with small simple spines, which, under the microscope, are seen to be slightly rough at their tips ; just over each arm they are much shorter, and extend to the first upper arm-plate. Radial shields and scaling wholly obscured by thick skin and spines, except on a small patch next mouth-shields. Seven regular, not thorny, nearly cylindrical, rather slender arm-spines, which taper slowly to a blunt point ; lengths to that of an arm-joint 2, 3, 2, 1.5, 1.5, 1.5, 1 : .8. Tentacle-scales long, pointed, and rather wide ; two on each of first two or three pores, and one on those beyond. Color in alcohol, white.

Station 164, 950 fathoms, 1 specimen.

This species is distinguished from *O. segesta* by more numerous and different mouth-papillæ and by stouter arm-spines.

Ophiacantha segesta sp. nov.

Plate X. Fig. 271.

Special Marks. — Disk beset with short, smooth, slender spines, mingled with minute thorny stumps ; arm-spines not thorny.

Description of an Individual (Station 56). — Diameter of disk 3.5 mm. Length

of arm 15 mm. Width of arm without spines 1 mm. Seven regular, sharp, conical mouth-papillæ to each angle, whereof the innermost is much the largest, and resembles the teeth, which are stout, blunt, spearhead-shaped. Mouth-shields small, wider than long, with a point within and a curve without. Side mouth-shields wide, thick, and somewhat curved. Under arm-plates thick and swollen, pentagonal, with an angle inward and outer side widest. Upper arm-plates thick and swollen, short fan-shaped, with an angle inward. Side arm-plates large, meeting widely above and below, swelling gradually to form the spine-ridges, which are not narrow or abrupt. Disk thickly set with small, slender, smooth spines (Pl. X. Fig. 271), among which appear minute thorny stumps and crochets. Scaling and radial shields hidden, except outer tips of the latter. Seven smooth, tapering, cylindrical arm-spines near base of arm, of which the two upper ones are much the longest, attaining a length of 1.7 mm.: the lower ones are short and stout. At tip of arm the lowest spine is slender, a little curved, and slightly rough on its edge. One small pointed tentacle-scale. Color in alcohol, white.

A young and immature specimen, but distinctly characterized by its spiny disk.

Station 56, 1075 fathoms, 1 specimen.

Ophiacantha Troscheli sp. nov.

Plate IX. Figs. 222-224.

Special Marks. — Narrow, ridge-like radial shields, which are partly naked. Disk beset on radial shields and centre with short, scarcely thorny spines, and in the interbrachial spaces with grains. Arms long and sinuous. Five or six stout, nearly smooth arm-spines.

Description of an Individual (Station 33). — Diameter of disk 7 mm. Length of arm 84 mm. Width of arm without spines 1.8 mm. Seven stout, short, blunt-pointed mouth-papillæ to each angle, of which the innermost, standing under the teeth, is sometimes represented by two. Six or seven short blunt teeth. Mouth-shields small, with an angle within and a curve without; length to breadth .8 : 1.2. Side mouth-shields wide, with curved sides, extending well beyond mouth-shield on either side and meeting within. Under arm-plates rather thick and somewhat obscured by skin; rudely pentagonal, with an obtuse angle inward; first plate longer than broad, irregular, compressed, six-sided; second plate also longer than broad, curved without and wider than within. Upper arm-plate rather thick, yet showing the median ridge of the underlying arm-bone; four-sided, outer side curved or wavy, and wider than inner one, lateral sides nearly straight; length to breadth 1.2 : 1.2. Side arm-plates not meeting above near base of arm, and barely touching below; projecting very slightly even near end of arm, so that the knotted or bead-like outline usual in the genus is not seen. Disk set with numerous, essentially smooth spines about 1 mm. long, which stand mostly in centre and on radial shields; interbrachial spaces sparsely granulated. Radial shields naked for a

large part of their length, long, narrow, joined, raised above surrounding surface; scaling hidden. Five or six essentially smooth, tapering, and nearly equal arm-spines, of which, however, the upper one is much the stoutest; lengths to that of an arm-joint 1.8, 1.6, 1.5, 1.5, 1.5 : 1.2, or 2.2, 1.6, 1.5, 1.3, 1.3, 1.3 : 1.2. Tentacle-scales flat, pointed, and rather small. Color in alcohol, pale brown.

The species stands near the typical *O. setosa* in respect to form of disk and length of arm; but it differs from this and most others of the genus in having naked radial shields and side arm-plates, which do not project to give a knotted look to the arm.

Station 33, off Bermudas, 300 fathoms, 1 specimen. Two specimens from the "Blake" expedition, dredged in 101 fathoms by A. Agassiz, showed no important variations. The disk-grains were larger and more numerous.

Ophiacantha cuspidata sp. nov.

Plate X. Figs. 248-250.

Special Marks. — Disk beset with thorny stumps; eight rather long, stout, and feebly thorny arm-spines: about eleven long slender mouth-papillæ.

Description of an Individual (Station 344). — Diameter of disk 9 mm. Length of arm 63 mm. Width of arm without spines 3 mm. Ten or sometimes eleven long, flat, rather slender and irregular mouth-papillæ, of which the outer one has often a spatula shape. Teeth long, spearhead-shaped. Mouth-shields small, long pentagonal, with a wide obtuse angle within; length to breadth 1 : 1. Side mouth-shields small, narrow, and crowded, meeting within. Under arm-plates wider without than within, where they touch the next plate; bounded without by a rounded angle or a somewhat deep curve, within by a more gentle curve, and on the lateral sides, opposite tentacle-scales, by re-entering curves. The second plate is narrower within, and has a wavy outer edge. Upper arm-plates fan-shaped, with an angle inwards; the lateral corners are sharp, and the lateral sides slightly re-enteringly curved. Side arm-plates moderately prominent, meeting narrowly above, but not below at base of arm. Disk moderately thick, not puffed, closely set with stout little stumps each bearing a crown of five or six minute thorns. Radial shields and disk-scales hidden by skin and the thorny stumps, except that the position of each radial shield is usually marked by a shallow furrow. Eight stout, long cylindrical arm-spines, tapering to a blunt point and set with fine thorns; lengths to that of an arm-joint 3.6, 5, 3, 2, 2, 2, 1.8, 1.4 : 1. On first pore two tentacle-scales; on the rest a single large pointed scale. Color in alcohol, dark straw.

A young specimen with a disk of only 1.5 mm. had an arm of 10 mm. The disk armature was little crochets with two or three prongs; the arm-joints were of course more constricted, and the upper and under arm-plates were widely separated; there were four or five arm-spines, whereof the first or second was much the longest; to each mouth-angle seven papillæ, whereof the lateral were bead-like and had not yet become long and slender.

Station 344, 430 fathoms, 12 + and 5 young specimens.

Ophiacantha longidens sp. nov.

Plate X. Fig. 274.

Special Marks. — Disk closely set with slender stumps, each bearing a crown of three to five long delicate thorns; arm-spines translucent and thorny; seven long slender mouth-papillæ; tentacle-scales spiniform.

Description of a Specimen (Station Cebu, Philippines). — Diameter of disk 4 mm. Width of arm without spines 1 mm. Seven mouth-papillæ to each angle, of which the lateral are long, spine-like, and blunt; and the innermost one is of a blunt spearhead form, like the four teeth above it. Mouth-shield small, wider than long, bounded by a curve without, and an angle within. Side mouth-shields small, narrow, meeting within. First under arm-plate small and rounded; second of an irregular transverse diamond-shape, wider than long, having the lateral corners sharp, and a slight lobe without (Fig. 274); those immediately beyond are similar, having a wide axe-shape, with a clean curve without. Upper arm-plates small, of a wide fan-shape, with the angle inward, and lateral corners sharp. Side arm-plates rather large, meeting above and below, with a well-marked spine-ridge. Disk round, slightly puffed, densely set with slender, minute stumps, each bearing a crown of three to five long slender thorns. Scaling and radial shields hidden, except the outer tips of the latter. Seven flattened, translucent, thorny, rather blunt arm-spines; lengths to that of an arm-joint 2, 2, 1.7, 1.7, 1, 1, .8 : .7. One spiniform tentacle-scale. Color in alcohol, above, mottled brown; below, white with brown markings on arms.

Cebu, Philippines, 95 – 100 fathoms, 1 specimen.

Ophiacantha nodosa sp. nov.

Plate X. Figs. 258 - 261.

Special Marks. — Six arms; seven long mouth-papillæ to each angle; disk closely set with coarse, stout stumps having thorny ends and sides.

Description of an Individual (Station 3). — Diameter of disk 7 mm. Width of arm without spines 2.3 mm. Seven narrow mouth-papillæ, the outer one longest. Teeth long and narrow, though stouter than mouth-papillæ. Mouth-shield small pentagonal, with a wide angle inward; length to breadth .7 : .7. Side mouth-shields long, narrow and curved, meeting within and extending without much beyond the mouth-shield. Under arm-plates pentagonal, with a strongly curved outer side, and lateral and inner lateral sides re-enteringly curved; length to breadth (third plate) .8 : 1. Upper arm-plates broad, transverse diamond-shape, widely separated. Side arm-plates stout and prominent, meeting freely above and below. Disk densely set with coarse stumps, which bear a crown of strong thorns and are also usually thorny on their sides. Radial shields and scaling hidden, except the outer tips of the former.

Seven or eight slender, feebly thorny arm-spines; the upper one longest (3 mm.), the three lowest about equal. Tentacle-scales long, large, and pointed. Color in alcohol, gray.

Station 3, 1530 fathoms, 1 specimen.

The only specimen was a disk with the bases of the arms and a few arm-spines. The characters were, however, distinct.

Ophiacantha cornuta sp. nov.

Plate X. Fig. 266.

Special Marks. — Disk-scales distinct and rather large, closely beset with small stumps, having a slender trunk bearing a crown of six or eight minute thorns. Lowest arm-spine thickened and curved.

Description of an Individual (Station 171). — Diameter of disk 5.5 mm. Width of arm without spines 2 mm. Seven mouth-papillæ to each angle, of which the three innermost are long, cylindrical, and pointed; the odd one at angle of jaw being largest. Mouth-shields much wider than long, with a curve without and an obtuse angle within; length to breadth .6 : 1.2. Side mouth-shields wide and stout, broadly joined within. Under arm-plates much wider than long, slightly curved without, having a little peak within, and the very short lateral sides re-enteringly curved; length to breadth .6 : 1.2. Upper arm-plates small, much wider than long, almost of a transverse diamond-shape, and lower than the ridge of the side arm-plates, which are large, meeting broadly above and below, and have an unusually narrow projecting spine-ridge continuous over the top of the arm. Disk, including radial shields, covered by distinct imbricated scales, two or three in the length of a mm., closely beset and partly obscured by little stumps consisting of a slender trunk bearing a crown of six or eight minute thorns. Eight translucent arm-spines, all sharp and strongly thorny, except the lowest, which is thickened, curved, and slightly rough. Towards end of arm this spine is more curved and proportionately larger, and stands below three very slender arm-spines (Pl. X. Fig. 266). Tentacle-scale flat, stout, pointed. Color in alcohol, white.

This specimen was plainly not fully grown, and was imperfect by loss of some arm-spines, etc., but the adult does not probably differ much, while the hooked lowest arm-spine and character of disk mark it well as a species. A young individual (Fiji Islands), with a disk of 3 mm. and arms 14 mm. long, presented no variations beyond those of age, except that the lowest arm-spine was rather less curved; there were four spines besides this, the uppermost being sometimes as long as 1.7 mm.

Station 170, 520 fathoms. Station 171, 600 fathoms. Fiji Islands, 520 fathoms.

Ophiacantha cosmica sp. nov.

Plate X. Figs. 251 - 254, 262 - 265, 269, 270.

Special Marks. — Eight or more feebly thorny arm-spines. Side arm-plates only moderately prominent. Disk crochets rather coarse.

Description of an Individual (Station 157). — Diameter of disk 18 mm. Length of arm 100 mm. Width of arm without spines 4 mm. Seven mouth-papillæ to each angle, whereof the innermost is broad and flat, like the teeth; the others are short, pointed, and very stout; outside these, and a little higher in mouth-slit, is often a rounded scale of the second mouth-tentacle. Besides these, there are, on the mouth-frames, from two to four small, peg-like papillæ. Mouth-shields wide heart-shape, with angle inward; length to breadth 2 : 3.5. Side mouth-shields rather narrow, somewhat curved, meeting within, closely joined to surrounding parts. Under arm-plates wide pentagonal, with outer side curved, and laterals a little re-enteringly curved. Upper arm-plates wide fan-shaped, with an angle inward, which in the basal plates is truncated. Side arm-plates stout and moderately prominent; meeting below, near base of arm, but not above. Towards end of arm they meet above and below, and are more prominent, so as to give it a somewhat knotted look. Disk full, and rising considerably above the arms; densely and evenly set with small stumps, which, being freed of skin, are seen to be composed of five or six thorns, of different lengths, soldered side by side; these stumps appear also on the first two upper arm-plates. Radial shields and disk-scales hidden. Eight even, translucent, cylindrical arm-spines, which taper to a blunt point and are under the microscope slightly rough but not thorny; lengths to that of an arm-joint 3.5, 3.5, 2.8, 2.5, 2.5, 2.2, 2, 2 : 1.5. Tentacle-scales rather small, longer than broad, pointed. Color in alcohol, straw.

The specimen just described is unusually large for this division of the genus, which leads one to think that the bulk of those now known are immature, and therefore to be treated with all the more caution. The young of *Ophiacantha* differs from the adult as follows: 1. the arm-spines are fewer, longer, and more slender and thorny; 2. the side arm-plates are much larger and more projecting, giving a strongly knotted or beaded look to the arm; 3. the mouth-papillæ are often less numerous and more slender; 4. the armature of the disk is more delicate, and the stumps or spines more thorny. Thus, a younger specimen from the same station had a disk of 6 mm. in diameter and an arm 33 mm. long. There were seven slender arm-spines, the upper ones much the longest, and bearing fine thorns on the lower part of the shaft; the arms were decidedly knotted, though not so much so as in some other species (e. g. *O. serrata*). The disk-stumps had a short trunk which supported a crown of four or five thorns, and resembled Fig. 265, of Plate X.

Another specimen (Station 122) was a little larger than the foregoing, and resembled it. There were eight scarcely thorny arm-spines, the three uppermost much the longest, 3.3 mm. (Pl. X. Fig. 262). The disk was closely and evenly

set with slender stumps, having a trunk surmounted by a crown of rather long thorns (Fig. 263). Station 218 furnished specimens remarkable for the number of arm-spines, with a disk of only 7 mm. and arms of 32 mm. There were eleven arm-spines, the uppermost being 2.3 mm. long, the lowest 1 mm., and the rest intermediate (Pl. X. Fig. 264); the disk-stumps were as in Station 122, but stouter (Fig. 265). The great number of arm-spines in rather small individuals is a grave variation; but others from the same quarter of the globe (Station 191) were normal in this respect. A specimen off Tristan d'Acunha had a disk 7 mm. in diameter and the arm about 37 mm. long. The outermost mouth-papilla on either side was wide (Pl. X. Fig. 269), and the next two were longer than usual. The upper arm-spine was 3 mm. long, and feebly thorny for its whole length.

Ophiacantha cosmica appears in the entire southern hemisphere, from the Brazil coast, by the lone Island of Tristan d'Acunha, the antarctic zone, off New Guinea, and between Juan Fernandez and the South American coast, where it lives in 2225 fathoms. Off Brazil it is found in only 350 fathoms. Its extreme variations are described above, and are not very great.

Stations 122, 350 fathoms, 12 + specimens. Off Tristan d'Acunha, 1000 fathoms, 2 specimens. Station 146, 1375 fathoms, 2 specimens. Station 147, 1600 fathoms, 12 + specimens. Station 153, 1675 fathoms, 11 specimens. Station 156, 1975 fathoms, 3 specimens. Station 157, 1950 fathoms, 2 specimens, and 2 young. Station 158, 1800 fathoms, 2 specimens. Station 191, 800 fathoms, 7 specimens. Station 218, 1070 fathoms, 10 specimens. Station 298, 2225 fathoms, 2 specimens. Station 299, 2160 fathoms, 9 specimens.

Ophiacantha levispina sp. nov.

Plate X. Fig. 277.

Special Marks. — Disk closely beset with fine stumps bearing crowns of minute thorns; seven slender, not thorny arm-spines; outer side of under arm-plates strongly curved.

Description of an Individual (Station 214). — Diameter of disk 6 mm. Length of arm 36 mm. Width of arm without spines 2 mm. Mouth-papillæ seven or nine to each angle, whereof the outer one on either side is broad and scale-like, while the other five or seven are sharp and conical. Mouth-shields broad heart-shape, with the point inward; length to breadth 1 : 1.3. Side mouth-shields rather narrow, of nearly equal width, meeting within. Under arm-plates wider than long, with a slight peak within, and the outer side (especially little way out on arm) very strongly curved. Upper arm-plates very small, sunken below the ridge of side arm-plate, of a rounded fan-shape, with an angle inward. Side arm-plates large, meeting broadly above and below, with a spine-ridge which swells gradually from the plate, and does not form a steep narrow crest. Disk densely beset with very fine, thorny stumps, similar to Fig. 263, Plate X., but with a more slender trunk; radial shields and scaling hid-

den. Seven long, slender, translucent arm-spines, essentially smooth, only the lower ones being slightly rough under the microscope. Lengths to that of an arm-joint 3.5, 3.5, 3.5, 2.8, 1.8, 1.3, .8 : .8. Tentacle-scales narrow and sharp. Color in alcohol, white.

The great size of the side arm-plates and the number and length of the arm-spines mark this as an immature specimen, but the specific characters are not found in any other.

Station 214, 500 fathoms, 1 specimen.

Ophiacantha serrata sp. nov.

Plate X. Figs. 272, 273.

Special Marks. — Disk closely and evenly set with minute grain-like stumps bearing a crown of blunt thorns; arm-spines long, slender, strongly thorny, translucent, mounted on steep, narrow, much projecting side arm-plates.

Description of an Individual (Station 219). — Diameter of disk 6 mm. Length of arm about 32 mm. Width of arm without spines 1.8 mm. Seven flat, rather blunt mouth-papillæ, not crowded; the innermost one much larger and squarish; besides these, the first under arm-plate bears two tentacle-scales, one to each of second pair of mouth-tentacles. Four flat teeth, similar in shape to the innermost mouth-papilla. Mouth-shields much wider than long, of a transverse diamond-shape, with lobe-like angles. Side mouth-shields straight and narrow, nearly or quite meeting within. First under arm-plate small and rounded, and bearing on its inner edge two tentacle-scales; second plate long axe-shaped, with a curve without, a well-marked angle within, and lateral sides re-enteringly curved; third plate proportionately shorter and with the inner side a very obtuse angle. Upper arm-plates small, of a wide fan-shape, with the angle inward. Side arm-plates large, meeting widely above and below, rising very suddenly to form a high, narrow spine-ridge, so that the arm has the look of a series of short cylinders alternating with burrs (Fig. 272). Disk densely and evenly beset with minute grain-like stumps, bearing a crown of blunt thorns (Fig. 273). Scaling and radial shields covered, except outer tips of the latter. Nine long, slender, translucent, strongly thorny arm-spines; lengths to that of an arm-joint 4, 4, 4, 3.2, 2.7, 2.5, 1.8, 1.8, 1.3 : 1. One small spiniform tentacle-scale. Color in alcohol, white mottled with pale brown.

The small number of teeth and large side arm-plates show the specimen to be young, but the specific marks are good, and would be carried forward to the adult, which doubtless has ten or a dozen long, glassy, thorny arm-spines, with side arm-plates not so exaggerated in their projection.

Station 219, 152 fathoms, 1 specimen.

Ophiacantha vivipara Ljn.

Ophiacantha vivipara, Tvänne Nya Ophiurid. Öf. Kong. Akad. p. 471. 1870.

Marion Island, 50 – 75 fathoms, 12 + specimens. The following three places in the Kerguelen Islands: Christmas Harbor, 120 fathoms, 12 + specimens; Balfour Bay, 20 – 60 fathoms, 1 specimen; Royal Sound, 25 fathoms, 12 + specimens. Station 151, 75 fathoms, 8 specimens. Station 313, 55 fathoms, 12 + specimens. Station 314, 70 fathoms, 1 specimen. Station 320, 600 fathoms, 7 specimens.

Ophiacantha bidentata Ljn. MS.

Asterias bidentata Retz., Dissertatio, p. 33. 1805.
Ophiacantha spinulosa Müll. and Trosch., Syst. Asterid. p. 107. 1842.

Dr. Ljungman showed me at Stockholm the original of Retzius, which is, without question, this species.

Station 45, 1240 fathoms, 8 specimens. Station 46, 1350 fathoms, 12 + specimens. Station 49, 83 fathoms, 6 specimens.

OPHIOTHAMNUS Lym.

Ophiothamnus remotus sp. nov.

Plate VIII. Figs. 201 - 203.

Special Marks. — Disk-scales coarse and angular. Side mouth-shield very large, and meeting broadly within. Very few short spines on disk.

Description of an Individual (Station 142). — Diameter of disk 3.3 mm. Length of arm 11 mm. Width of arm without spines 8 mm. Seven flat close-set mouth-papillæ; the odd one, at the apex, being short spearhead-shaped, the rest squarish. Mouth-shields small, three-sided, with a point inward, and the outer corners rounded; length to breadth .4 : .3. Side mouth-shields very wide and large, meeting broadly within, and enveloping the mouth-shield on all sides but one. First under arm-plate small and wedge-shaped, with inner end rounded; the rest are pentagonal, with an obtuse angle inward, and outer corners somewhat rounded; the second plate is larger than those beyond. Side arm-plates meeting broadly above and below, constricted within, swelling outward into a thickened spine-ridge. Upper arm-plates wider than long, irregular oval, with a slight peak within. Disk rather thick, covered above with coarse angular scales, whereof there are but two radiating rows in each interbrachial space; radial shields wide pear-seed shape, with a rounded angle inward, joined their whole length, except their inner ends, which are separated by a wedge-scale; interbrachial spaces below with a marginal constriction, and usually covered by four large rounded scales; there are a few short smooth disk-spines. Seven slender, translucent, sharp, not

thorny arm-spines ; lengths to that of an arm-joint 1.3, 1.3, 1, 1, .6, .4, .4 : .5. Beyond the basal joints there are but six spines, whereof the upper are shorter than those described above. One very small, narrow, pointed tentacle-scale. Color in alcohol, nearly white.

Station 142, Agulhas Bank, 150 fathoms, 4 specimens.

O. vicarius bears a general resemblance to this species, but is distinguished by narrower side mouth-shields and by long and numerous disk-spines.

Ophiothamnus vicarius Lym.

Ophiothamnus vicarius, Bull. Mus. Comp. Zoöl. I. No. 10, p. 342. 1869.

Station 23, 450 fathoms, 8 specimens.

OPHIOMITRA.

TABLE OF SPECIES HEREIN DESCRIBED.

Radial shields depressed ; along their outer corners and along margin of disk are large, somewhat swollen plates, wider than long ; the median interbrachial space filled by smaller plates or scales. Five to eight arm-spines. In alcohol, each interbrachial space contracts, forming a depression or crease.	Mouth-papillæ inclined to strong spiniform. Arm-spines stout. Outer edge of under arm-plates swollen, and in large specimens turned down. Five or six arm-spines.	*O. plicata.*
	Eight spines, less stout than in *O. plicata*, and disk-scales finer. Tentacle-scales jagged or thorny.	*O. Sarsii.*
	Radial shields widely separated, the large disk-plates running along their entire interbrachial margin. Under arm-plates not swollen. Under arm-spine thickened, and beyond middle of arm bent.	*O. chelys.*
	Outer edge of under arm-plates swollen. Tentacle-scales thorny. Under arm-spines straight.	*O. carduus.*
	Upper arm-plates long and slender. Marginal disk-plates large, and much swollen. Central disk-scales fine, and bearing minute thorny stumps.	*O. dipsacos.*

Ophiomitra plicata sp. nov.

Plate VIII. Figs. 209-212 ; Plate IX. Figs. 233-235.

Special Marks. — Mouth-papillæ thick, spiniform. Arm-spines five or six, stout and cylindrical. Outer edge of under arm-plates swollen and in large specimens turned down. Disk-spines stout and conical.

Description of an Individual (Station 205). — Diameter of disk 16 mm. Length of arm about 132 mm. Width of arm without spines 5 mm. Mouth-papillæ nine to each mouth-angle ; stout, spiniform, about equal, blunt. Teeth similar to mouth-papillæ, but shorter and flatter. Mouth-shields small, as long as broad, with an irregular outline ; the outer margin more or less thickened and curled downwards ; length to breadth 2 : 2. Side mouth-shield broad, thick, and closely joined to the surrounding parts. Under arm-plates broader than

long, broader without than within, separated by transverse depressions; outer edge much thickened and curled downwards. Near end of arm they are wide pentagonal, with an angle inward and the outer edge scarcely thickened. Side arm-plates slightly projecting near base of arm; meeting narrowly below, and scarcely or not at all above. Upper arm-plates wider than long, irregular in shape, with a curved outer side and an obtuse or irregular angle inward; length to breadth about 1.5 : 3.5. Disk (in alcohol) thick, rising well above the arms, and with a deep constriction and furrow in each interbrachial space. Along the outer portion of the interbrachial edge of each radial shield lie three or four plates, broader than long, and running diagonally outward; the rest of the disk is occupied by coarse, irregular, overlapping scales, beset with short, stout, blunt, smooth, conical spines, which form an irregular line over the base of each arm. Radial shields sunken, much longer than broad, narrowest within, rounded and swollen without; length to breadth 5 : 2; separated by one or more narrow scales. Five stout, cylindrical, rather short arm-spines, tapering to a blunt point, with thorns on all sides; lengths to that of an arm-joint 3.7, 4, 3.7, 3, 2.5 : 2. Two thirds out on the arm, the second spine is much longer and attains a length of 8 mm. Tentacle-scales very stout, and thickened at the base; pointed at the tip. On each of the first pair of pores there usually are three, on the rest only one. Towards tip of arm the scale becomes spiniform. Color in alcohol, pale brown.

Station 205, 1050 fathoms.

Smaller specimens (Station 214, Pl. IX. Figs. 233–35) presented considerable variations: with a disk of 10 mm. the arm was 60 mm. long; there were only seven mouth-papillæ to each angle; the disk-spines were thorny, the upper arm-plates narrow; the outer edge of the under arm-plates was somewhat swollen, but not curled down; the first tentacle-pore had only one or two scales; there were six comparatively long arm-spines, whose lengths to that of an arm-joint were 5.2, 3, 2.8, 1.8, 1.8, 1.5 : 1.3. Other specimens (Station 170), with disks from 12 mm. to 9 mm. in diameter, had smooth disk-spines, like 205, and six arm-spines, and upper and under arm-plates, like 214. The number of mouth-papillæ to each angle varied from seven to ten, without reference to size of specimen.

Station 170, 630 fathoms, 6 specimens. Station 205, 1050 fathoms, 1 specimen. Station 214, 500 fathoms, 3 specimens.

Ophiomitra Sarsii sp. nov.

Plate VIII. Figs. 216, 217.

Special Marks. — Eight stout cylindrical arm-spines. Tentacle-scales flat, tapering, jagged. Scaling of disk finer than in *O. plicata.*

Description of an Individual (Station 146). — Diameter of disk 15 mm. Length of arm about 100 mm. Width of arm without spines 4.5 mm. Seven or eight thick pointed mouth-papillæ to each angle. Seven teeth of similar form, but

more blunt and flat. Mouth-shields small, as long as broad, with an irregular outline ; outer margin more or less thickened and turned downward ; length to breadth 2 : 2. Side mouth-shields broad and thick, and closely joined to surrounding parts. Under arm-plates broader than long, broader without than within, separated by slight transverse depressions ; outer edge thickened, especially at its middle point. Midway on the arm, they are wide pentagonal, with an obtuse angle inward, and the outer edge not thickened. Side arm-plates slightly projecting, meeting near base of arm narrowly below and scarcely or not at all above. Upper arm-plates separated by transverse creases, thick, wider than long ; widest without, where they are bounded by a gentle curve ; inner side making a deep irregular curve. Disk (in alcohol) thick, rising well above the arms, with a deep constriction and furrow in each interbrachial space. On margin of disk and along outer interbrachial edge of radial shields lie three or four wide plates larger than the rest, which are coarse, irregular, overlapping scales, beset with short, stout, smooth, often club-ended spines, which are found also on edge of disk over the arms. Radial shields pear-seed shaped, with point inward, sunken, outer end rounded, separated widely by a broad wedge of scales ; length to breadth 4 : 1.8. Near base of arm eight stout, glassy, blunt, cylindrical, very thorny spines, of which the under are nearly as long as the upper ; lengths to that of an arm-joint 2, 3.8, 3, 2.8, 2.8, 2.8, 2.5, 2.5 : 1.7. Two thirds out on the arm there are only four spines, of which the second is much the longest, 5.5 mm. Two tentacle-scales on the first pore, one on the others ; stout, pointed, flattened, cloven or jagged on the edges ; farther out they take on the form of stout, very thorny spines. Color in alcohol, dull gray.

A smaller specimen with a disk of 10 mm. varied little, except that the upper arm-plates were narrower and thinner, and the disk-scales smaller and beset with few spines. This species differs from *O. plicata* in the cloven or thorny tentacle-scales and in the greater number of arm-spines.

Station 146, 1375 fathoms, 3 specimens.

Ophiomitra chelys.

Ophiacantha chelys Wyv. Thom., Voyage of the "Challenger." Atlantic, Vol. II. p. 64, Figs. 16, 17.

Plate IX. Figs. 239-241.

Special Marks. — Radial shields widely separated ; along their entire interbrachial margin run large disk-plates. Under arm-plates not swollen. Tentacle-scales large and flat. Under arm-spine thickened and curved.

Description of an Individual (Station 84). — Diameter of disk 9 mm. Length of arm about 85 mm. Width of arm near base 2.8 mm. Mouth-papillæ usually eleven to each angle, of which the central one within is wide and flat ; the three next on either side are stout and pointed, and the outer ones are irregular, compressed, and sometimes broken. Teeth similar in shape to the odd inner-

most mouth-papilla.* Mouth-shields small, as long as broad, shield-shaped, with a well-marked obtuse angle inward and outer margin sometimes turned down; length to breadth 2 : 2.3. Side mouth-shields broad and thick, a little widest at outer ends. Under arm-plates large, thick, and regular, much wider than long, reaching at their outer edge entirely across the arm; cleanly curved without, re-enteringly curved on sides, and having a little peak within where separated from next plate. First plate small, narrow wedge-shaped. Upper arm-plates somewhat swollen, widely separated, wider than long, bounded without by a gentle curve, and within by an obtuse angle or a deep curve. Side arm-plates prominent and meeting freely above and below. Disk thick and rising well above the arms, with a very deep, narrow constriction and furrow in each interbrachial space. The space between this furrow and the radial shields is on either side occupied by four large plates running diagonally inward, whereof one or more are often broken in two. The central disk is sunken, and covered by small, coarse, irregular scales, which, with the larger plates, are sparsely beset with short, blunt, usually smooth stumps or spines, which form also an irregular clump over each arm. Radial shields deeply sunken in a furrow, widely separated by a high ridge of irregular scales, much longer than broad, presenting an acute angle inward; length to breadth 3 : .8. Near base of arm six stout, very thorny, glassy, blunt, cylindrical arm-spines, the lowest ones much the stoutest; lengths to that of an arm-joint 3.6, 3.6, 2.8, 1.7, 1.7, 1.7 : 1.2. Two thirds out on the arm the spines are more slender, and the second much longer, attaining to 5 mm. The under spine is marked by its thickness; beyond base of arm it is somewhat curved. Tentacle-scales large, thick, pointed, flattened, sensibly smooth, except towards end of arm, where they bear two or three microscopic thorns. Color in alcohol, dull straw.

It is not easy to say how much of the peculiar creasing of the disk and sinking of the radial shields is due to the contraction of the animal drawn from a depth and immersed in strong alcohol, and how much is natural. Of nine specimens one had radial shields much wider and more nearly on a level with the disk; but in the rest the radial shields were deeply sunken. Six specimens from the "Blake" expedition (Agassiz and Sigsbee, 1878) seemed a variety of this species. They were from 480 to 860 fathoms, near Cuba. All had the radial shields not at all sunken and of a broad pear-seed shape; only the centre of the disk bore stumps, which were little articulated cylinders bearing a crown of thorns. The largest specimen, with a disk of 8 mm., had seven arm-spines, which were stouter than in "Challenger" specimens and shorter, their lengths being 2, 3, 2.2, 2, 1.5, 1.5, 1.2; and the lowest spine, though thick, was scarcely or not at all curved. The other specimens were young, and had long slender arm-spines, and the under one curved. The "Challenger" specimen from Station 33 resembled these.

Station 3, 1530 fathoms, 3 specimens. Station 33 (var.?) 300 fathoms, 3 specimens. Station 84, 1124 fathoms, 3 specimens.

* The nomenclature of the various papillæ of the mouth is of course conventional. In most cases the lowest tooth may also be called the innermost mouth-papilla.

Sir Wyville Thomson *loc. cit.* records his specimen from Station 87. This was never sent me; the only *Ophiomitra* from Station 87 being the allied species *O. carduus*, which does not agree with his figure and description of *O. chelys*. The statement (p. 65) that the arm is only three and a half times the diameter of the disk is plainly a misprint.

Ophiomitra carduus sp. nov.

Plate IX. Figs. 236-238.

Special Marks. — Outer edges of under arm-plates swollen. Tentacle-scales strongly thorny. Under arm-spine straight.

Description of an Individual (Station 87). — Diameter of disk 10 mm. Width of arm without spines 2.8 mm. Mouth-papillæ nine to eleven to each angle, of which the inner central one has a flat spearhead-shape; the others irregularly conical with blunt points; several of them much larger, and resembling the innermost one; others, especially the outermost, small, crowded, and ill-defined. Mouth-shields small, broader than long, with an obtuse angle within and a truncated angle or a broken curve without, outer edge somewhat indented; length to breadth 1.7 : 2.2. Side mouth-shields very broad and curved on their outer edge, almost crescent-like. Under arm-plates near base of arm large, much wider than long, with a small swelling at their outer edge, which is gently curved and reaches nearly across the arm; lateral sides re-enteringly curved, with a peak within, where each plate is widely separated from its neighbor by the side arm-plates. Upper arm-plates somewhat swollen, bounded without by a gentle curve, and within by an obtuse angle or a deep curve. Side arm-plates stout and prominent, meeting broadly below, and, beyond the third plate, above also. Disk moderately thick, rising somewhat above the arms, with a deep constriction in each interbrachial space. The area between this constriction of the radial shields is occupied on either side by four or five transverse plates running diagonally inward, whereof one or more are often broken in two. Central disk somewhat sunken and covered with coarse, irregular, overlapping scales, which, with the larger plates and edge of disk, are closely beset with little cylinders bearing a crown of thorns. Radial shields of an irregular pear-seed shape, with an angle inward, wavy, scarcely sunken, very wide, separated by a broad wedge of scales forming a median hump or ridge; length to breadth 3.7 : 2. Near base of arm, six rather stout, thorny, glassy, blunt cylindrical arm-spines, the lowest ones shortest and stoutest, but not curved; lengths to that of an arm-joint 3.3, 3.3, 2.1, 1.8, 1.8, 1.7 : 1.3. Beyond first pair of pores the tentacle-scales are cloven, or have a long point, with one or more side thorns; towards middle of arm these thorns become stronger and the scale more pointed. Color in alcohol, dull straw.

A smaller specimen, with a disk of 8 mm., had arms about 65 mm. long. The disk-stumps were more thorny than in the larger one, and the tentacle-scales, beyond middle of arm, were short spines, with several sharp, slender

side thorns. It is to be noticed that the size and shape of the tentacle-scale, when specimens of the same size are compared, give a pretty constant character in *Ophiacantha* and *Ophiomitra*.

Station 87, 1675 fathoms, 2 specimens.

Ophiomitra dipsacos sp. nov.

Plate VIII. Figs. 213-215.

Special Marks. — Upper arm-spines long and slender, marginal disk-plates large and swollen; central disk-scales fine, and bearing minute thorny stumps; arm wide.

Description of an Individual (Station 24). — Diameter of disk 10 mm. Width of arm without spines 3.4 mm. Mouth-papillæ nine to eleven to each angle, whereof the innermost odd one is flat spearhead-shaped; and the two outer ones on each side are ill-defined, being sometimes small papillæ, or again forming a sort of curled sheath to the mouth-tentacle; the other papillæ are pointed and flattened. Mouth-shields as long as broad, small, having an obtuse angle within, and a truncated angle or a deep curve without; outer edge often a little curled; length to breadth 2 : 2. Side mouth-shields wide, with outer side strongly curved. Under arm-plates, near base of arm, large, much wider than long, with an outer edge gently curved and slightly thickened, and reaching nearly across the arm; lateral sides re-enteringly curved, with a peak within, where each plate is separated from its neighbor by the side arm-plates. Upper arm-plates slightly swollen, bounded without by a gentle curve, and within by a deep curve or truncated angle; they are separated by side arm-plates, which are prominent, and meet freely above and below. Disk thick and puffed, rising well above the arms, with a constriction and furrow in each interbrachial space. The area between this constriction and the radial shields, on either side, is occupied by four transverse plates running diagonally inward, and outside these is a similar larger plate forming the margin of the disk. Central disk covered with fine overlapping scales, eight or ten on a line between central point and inner angle of radial shield; they are sparsely beset with minute stumps bearing a crown of thorns. On the disk margin, over each arm, a few small grains or stumps. Radial shields of a wide pear-seed shape, with an angle inward, nearly or quite joined without; separated within by a broad wedge of scales; length to breadth 2.8 : 1.7. Near base of arm six strongly thorny, glassy, cylindrical arm-spines, whereof the two upper ones are very long, slender, and tapering, and the lowest is thick and blunt; lengths to that of an arm-joint 5, 7, 3.5, 2.5, 2, 1.8 : 1.3. Two large pointed tentacle-scales on first pore; one on each of those beyond; toward middle of arm, the scales are more elongated and pointed, and have one or two microscopic thorns. Color in alcohol, very pale brown.

Station 24, 390 fathoms, 1 specimen.

OPHIOCAMAX gen. nov.

Ophiocamax vitrea sp. nov.

Plate VIII. Figs. 218-221; Plate IX. Figs. 242-244 (young).

Special Marks. — Mouth-papillæ numerous, spine-like, arranged in a tuft. Tentacle-scales blunt spiniform, two or three to each pore. Disk covered above with rounded, equal, thin scales set thickly with minute thorns and crochets.

Description of an Individual (Station 219). — Diameter of disk 17 mm. Width of arm without spines 4.4 mm. About thirty long, spiniform, equal papillæ to each angle, set in two or three ranks; of which half a dozen are arranged under the teeth, and may be considered tooth-papillæ; and three on either side are borne on a small plate or scale, at outer corner of mouth-slit, and cover the second mouth-tentacle. Seven broad flat teeth, with a rounded cutting edge. Mouth-shields small, broader than long, with an obtuse angle within and a truncated angle without, bearing a few short spines; length to breadth 1.5 : 2. Side mouth-shields exceptionally large and wide, meeting broadly within, having their inner sides gently curved. Under arm-plates with a wide, slightly curved, somewhat swollen outer edge, and a narrow projection within, where they join the next plates; on each lateral side a sharp re-entering curve, where the tentacle issues; length to breadth 2 : 2.6. Side arm-plates near base of arm not meeting below and scarcely above; forming broad, abrupt, but not very high ridges. Upper arm-plates slightly swollen, about as broad as long, with a gentle curve without and a deep curve within. The whole arm is sparsely set with minute points. Disk flat and even, closely set with fine short spines which are sharp and thorny or forked. Radial shields flat and regular, triangular, with an angle inward, bearing a few spines like those of the disk, and separated by a row of the same; length to breadth 4 : 2.5. Near base of arm nine slender, slightly flattened, glassy arm-spines, whereof the three lowest are very small. Unlike those of *Ophiacantha*, these spines are not hollow. Lengths to that of an arm-joint 3, 3, 3.6, 4, 3, 1.6, 1.2, .8, .6 : 2. Three stout, club-shaped, spiniform tentacle-scales on the first pore, and usually two on those immediately beyond. Color in alcohol, straw.

A younger specimen (Station 192, Pl. IX. Figs. 242-244), with a disk of 12 mm., had the upper arm-plates longer; the basal under arm-plates did not touch each other; the scaling of the disk was distinctly marked; there were three tentacle-scales on the basal pores; the arm-spines were seven; lengths to that of an arm-joint 2.2, 4.4, 3, 2.2, 2, 1.5, 1.2 : 1.5.

Station 192, 129 fathoms, 1 specimen and young. Station 201, 102 fathoms, 1 specimen. Station 204, 100 fathoms, 1 specimen. Station 219, 152 fathoms, 2 specimens.

OPHIOSCOLEX Müll. and Trosch.

Ophioscolex dentatus sp. nov.

Plate VII. Figs. 184 - 186.

Special Marks. — Three or four short, blunt, flattened arm-spines. Numerous mouth-papillæ, whereof the outer are flat spiniform. One tentacle-scale.

Description of an Individual (Station 142). — Diameter of disk 15 mm. Length of arm about 55 mm. Width of arm, without spines, close to disk 2.7 mm. There are seven mouth-papillæ on each side of an angle and one small and pointed at apex of jaw; the three outer are flat spiniform, and much the largest and longest. On removing the skin the mouth-shield is seen to be wide triangular, having an obtuse angle within and outer corners rounded. Side mouth-shields long, narrow, and meeting within. Arms covered by a thick skin completely hiding the plates, which are obscurely indicated below by transverse furrows. On removing the skin, the under arm-plates appear longer than wide, with a curve without and a re-entering curve within; the side arm-plates small and meeting neither above nor below, while the upper plates are only indicated by thin films of slightly calcified skin. Disk round and rather flat, covered with a soft naked skin variously wrinkled above and below.* Genital openings wide and long, extending from the mouth-shield to the edge of the disk. Three or four short, blunt, flattened arm-spines, equally spaced, about as long as an arm-joint; the upper and undermost usually a little the longest. One small rounded tentacle-scale on the inner side of the pore. Color in alcohol, light gray.

Station 142, off Agulhas Bank, 150 fathoms, 12 + specimens.

Ophioscolex tropicus sp. nov.

Plate VII. Figs. 190 - 192.

Special Marks.— Seventeen to nineteen small, short, pointed close-set mouth-papillæ, occupying the entire margin of each mouth-angle. Whole animal covered by a thick skin, through which appear the lower and side arm-plates, the mouth-shields, and (indistinctly) the scaling of the lower interbrachial space.

Description of an Individual (Station 24). — Diameter of disk 8 mm. Width of arm close to disk, without spines, 1.3 mm. Eight or nine short, close-set, rounded mouth-papillæ, occupying the whole length of each side, and one larger and more pointed at apex of jaw. Mouth-shields much broader than long, in shape transverse oval; length to breadth .6 : 1.2. Side mouth-shields long, curved and narrow, broader without, tapering inward, where they do not quite meet. First under arm-plate very small, nearly square, the others larger, long hexagonal, with outer side curved, lateral sides re-enteringly curved, and three inner sides short. Side arm-plates broad and thin, meeting near base of arm neither above nor below. The place of the upper arm-plates is occupied by thick skin,

* It is not often so *regularly* wrinkled as in Fig. 185.

through which may be distinguished the upper side of the arm-bones. Disk flat and thin, covered with a thick, slightly wrinkled skin, which conceals the radial shields and the fine scaling, though the latter may be distinguished in the lower interbrachial spaces. Genital scales quite hidden. Genital opening extending from the mouth-shield to the margin of the disk. Three cylindrical, stout, nearly equal, pointed arm-spines, about as long as an arm-joint. One small rounded tentacle-scale on inner side of the tentacle-pore. Color in alcohol, gray.

I admit this species to *Ophioscolex* with some hesitation. The mouth-papillæ are different in shape and arrangement; but the absence of upper arm-plates and the characteristic covering of smooth skin suggest its position.

Station 24, off St. Thomas, 390 fathoms, 1 specimen.

OPHIOLEBES * gen. nov.

Disk and arms stout, and covered by a thick skin, which bears grains or stumps, and hides more or less the underlying plates. Arm-spines short, blunt, thorny, covered by thick skin, and arranged on the sides of the side arm-plates, which project but slightly. Long stout mouth-papillæ, and teeth; no tooth-papillæ. Jaw-covers large and wide, making a circle by their connecting ends.† Arm-plates rather small, but normal, nearly as in *Ophiacantha.* Two genital openings in each interbrachial space.

Ophiolebes includes Ljungman's *Ophiactis clavigera*, besides the two species here described.

Ophiolebes scorteus sp. nov.

Plate VII. Figs. 196, 197.

Special Marks. — Four short blunt arm-spines covered with thick skin, the upper one longest. Five feeble mouth-papillæ to each angle. Radial shields like ridges and set with grains.

Description of an Individual (Station 145). — Diameter of disk 7.5 mm. Length of arm about 23 mm. Width of arm close to disk, without spines, 1.5 mm. There may be seen on each angle the outlines of five small mouth-papillæ, two widely separated on the sides and one longer and more slender at the apex, all covered by a thick skin, which, when removed, shows them as long, cylindrical, and stout. The mouth-shields, whose outlines may be vaguely seen, are small triangular, with an angle inward and outer edge curved. Side mouth-shields hidden by skin, which, when removed, shows them long and narrow, meeting within, and nearly or quite joining without, between first and second arm-plates, so as to form a continuous line about the mouth. First under arm-plate diamond-shape; the rest are pentagonal, with an angle inward

* ὄφις, snake; λέβης, basin.

† The *jaw-cover* is the internal plate which roofs over the open angle above each pair of mouth-frames in the interbrachial space.

and a notch without, but are hidden by thick skin. No side or upper arm-plates visible, but, on removing the skin, the latter are seen to be small triangular, and separated by the side plates. Disk round and arched, covered by a thick skin which in the centre is irregularly wrinkled. Radial shields like long narrow ridges covered with a thick skin and set with small flat grains; the brachial and interbrachial spaces have the skin more or less wrinkled, and often with a few grains; the lower interbrachial spaces have the same thick, somewhat wrinkled skin. There are on the first three joints three arm-spines; beyond this there are four; they are short, stout, and microscopically thorny, with blunt points, and are covered with thick skin; the upper spines being longest. No tentacle-scales. Color in alcohol, white.

Station 145, 310 fathoms, 12 + specimens.

Ophiolebes vestitus sp. nov.

Plate X. Figs. 255-257.

Special Marks. — Disk covered by thick skin and set with short stumps, or grains, bearing a crown of blunt thorns. Arm-spines short, stout, opaque, thorny. Mouth-papillæ stout, blunt, spiniform.

Description of an Individual (Station 308). — Diameter of disk 10 mm. Length of arm 50 mm. Width of arm without spines 2.3 mm. Nine mouth-papillæ, of which the lateral are stout, blunt, cylindrical, crowded, somewhat movable, and with rough ends; the innermost is flat and squarish, like the teeth. Mouth-shields small, wider than long, with a lobe without and an obtuse angle inward; length to breadth 1 : 1.2. Side mouth-shields somewhat curved, extending beyond mouth-shield, wider without than within, where they meet. Under arm-plates pentagonal, with a rounded angle inward. Upper arm-plates fan-shaped, with a truncated angle inward. Side arm-plates meeting narrowly above and below, projecting but slightly. Disk a little puffed, covered by thick skin, and sparsely but regularly beset with short stumps or grains bearing a crown of blunt thorns. Six stout, cylindrical, blunt, thorny arm-spines; lengths to that of an arm-joint 1.8, 1.2, 1, .8, .8, .8 : .8. One small, narrow, pointed tentacle-scale. Color in alcohol, white.

A young specimen with a disk of 4 mm. had arms 10 mm. long. The disk-stumps were longer, and like very short thick spines. The arm-spines were less thorny. In this stage it is very near the Ophiuran described by Ljungman as *Ophiactis clavigera*, which has the same habits also, and is doubtless the young of a form of *Ophiolebes*, like the present one. It differs in having the disk-scales and part of the radial shields naked.

That *O. clavigera* is of a novel type is shown by the fact that Ljungman considered it an extreme modification of *Ophiactis*, while Lütken deemed it nearer *Ophiacantha*.

Station 307, 140 fathoms, 3 specimens. Station 308, 175 fathoms, 7 specimens. Station 310, 400 fathoms, 1 specimen.

OPHIOSCIASMA * gen. nov.

Disk covered with thick soft skin finely granulated. Arms very slender, with lower and side plates imperfectly calcified, and no upper plates. Mouth-papillæ and teeth represented by a bunch of spines, or thorns, at apex of jaw. Arm-spines arranged on sides of side arm-plates. Two large genital openings in each interbrachial space.

A singular genus, which, by its disk covered with soft skin and lack of upper arm-plates, is allied to *Ophioscolex*, but differs by its granulation, and its extremely slender, knotted arms.

Ophiosciasma attenuatum sp. nov.

Plate VII. Figs. 193-195.

Special Marks. — Disk beset with a very fine but not continuous granulation. Arms very slender, knotted, and at centre of the joints diaphanous. Three small nearly equal arm-spines.

Description of an Individual (Station 122). — Diameter of disk 6 mm. Length of arm 45 mm. Width of arm without spines .6 mm. Mouth-papillæ, teeth, and tooth-papillæ combined in form of a clump of seven or eight sharp thorns or spines, standing round the apex made by the juncture of the long narrow mouth-frames. Mouth-shields of a transverse diamond-shape, very small, sometimes scarcely visible, more or less hidden by thick skin. Side mouth-shields very narrow and slender, meeting within. Under arm-plates very thin, and in their central part transparent, so that their outlines are vague; longer than broad, with outer side slightly curved and lateral sides re-enteringly curved; length to breadth .5 : .4. Side arm-plates reduced to a strip, like a double cord, running along the side of the joint. No upper arm-plates. The arm-bones are but slightly calcified, except at their thickened ends, so that their more slender central shaft is translucent. The arm thus presents a beaded appearance, with swellings where the ends of the arm-bones form joints and support the arm-spines. Disk covered with a thick skin, which above is beset with fine grains, and which partially obscures the mouth-papillæ and the arm-spines. No radial shields or disk-scales visible. Three small, blunt, nearly equal arm-spines, not so long as an arm-joint, seen to be microscopically rough when free of skin, and standing nearly at right angles to arm. Tentacles large, simple, and fleshy; no tentacle-scales. Color in alcohol, very pale yellow.

Station 122, 350 fathoms, 1 specimen.

* ὄφις, snake; σκιάσμα, shadow.

OPHIOGERON * gen. nov.

Disk covered by a naked skin. Mouth-angles naked, except a few small teeth on jaw-plate. Under arm-plates small, and with a large tentacle-pore on either side. Side arm-plates somewhat flaring, and carrying thorny arm-spines covered with skin. No upper arm-plates.

This genus is somewhat allied with *Ophiomyxa*, and with *Ophioscolex*.

Ophiogeron edentulus sp. nov.

Plate VII. Figs. 187-189.

Special Marks. — Two or three feeble, pointed teeth ; otherwise the mouth-angle quite naked. Two short stout arm-spines, which, stripped of skin, show longitudinal rows of hooked thorns.

Description of an Individual (Station 175). — Diameter of disk 3 mm. Length of arm about 14 mm. Width of same close to disk, without spines, 1 mm. Mouth-angles quite naked, except one small pointed papilla at apex of jaw and two or three more that represent teeth. Mouth-shields rounded triangular ; length and breadth about equal, with an angle within and outer side rounded. Side mouth-shields rather large, curved, longer than wide, broadest within, where they meet. First under arm-plate narrow, five-sided, with inner edge straight, a broad angle without, and re-entering curves on the lateral sides, second plate similar, but narrower and with the angle inward. Those beyond are further modified by having the outer and inner sides curved. Side arm-plates broad and meeting below, beyond the second under arm-plate ; flaring somewhat toward their outer edge. The arm-plates and mouth-shields are more or less obscured by thick skin. Along the upper side of the arm the central ridge of the arm-bones shows through the skin. Disk flat and thin, completely covered with a naked wrinkled skin. Two short tapering arm-spines, which when stripped of skin present longitudinal rows of slightly hooked thorns. No tentacle-scales, but large pores from which long smooth tentacles protrude. Color in alcohol, grayish.

Station 175, 1350 fathoms, 2 specimens.

* ὄφις, snake ; γέρων, an old man.

DESCRIPTION OF PLATES.

Those which have no authority appended are new species. In Plates III. and IV. some of the details are blurred by careless printing; the reader is therefore cautioned to compare figures with descriptions.

PLATE I.

Fig. 1. *Ophiomusium scalare*, below; $\frac{4}{1}$.
Fig. 2. " " above; $\frac{4}{1}$.
Fig. 3. " " arm-joints; $\frac{4}{1}$.
Fig. 4. " *lunare*, below; $\frac{4}{1}$.
Fig. 5. " " above; $\frac{4}{1}$.
Fig. 6. " " arm-joints; $\frac{4}{1}$.
Fig. 7. " *validum*, Ljn., below; $\frac{4}{1}$.
Fig. 8. " " above; $\frac{4}{1}$.
Fig. 9. " " arm-joints; $\frac{4}{1}$.
Fig. 10. " *simplex*, below; $\frac{4}{1}$.
Fig. 11. " " above; $\frac{4}{1}$.
Fig. 12. " *granosum*, below; $\frac{4}{1}$. Tentacle-holes omitted next second and third under arm-plates.
Fig. 13. *Ophiomusium granosum*, above; $\frac{4}{1}$.
Fig. 14. " *laqueatum*, below; $\frac{2}{1}$.
Fig. 15. " " above; $\frac{2}{1}$.
Fig. 16. " " arm-joint; $\frac{2}{1}$.
Fig. 17. " *cancellatum*, below; $\frac{4}{1}$. There should be small papillæ along the genital opening.
Fig. 18. *Ophiomusium cancellatum*, above; $\frac{4}{1}$.
Fig. 19. " *corticosum*, below; $\frac{3}{1}$.
Fig. 20. " " above; $\frac{3}{1}$.
Fig. 21. " *armigerum*, below; $\frac{2}{1}$. There should be papillæ along the genital opening.
Fig. 22. *Ophiomusium armigerum*, above; $\frac{4}{1}$. There should be an arm-comb of small papillæ.
Fig. 23. *Ophiomusium serratum*, below; $\frac{3}{1}$.
Fig. 24. " " above; $\frac{3}{1}$.
Fig. 25. " " arm-joint; $\frac{3}{1}$.

PLATE II.

Fig. 26. *Ophioglypha inornata*, above; $\frac{2}{1}$.
Fig. 27. " " below; $\frac{2}{1}$.
Fig. 28. *Ophiomusium archaster*, below; $\frac{3}{1}$.
Fig. 29. " " above; $\frac{3}{1}$.

Fig. 30. *Ophioplinthus medusa*, below ; $\frac{2}{1}$.
Fig. 31. " " above ; $\frac{2}{1}$.
Fig. 32. *Ophiomusium archaster*, arm-joints ; $\frac{3}{1}$.
Fig. 33. *Ophioplinthus grisea*, below ; $\frac{2}{1}$. The side mouth-shields should be visible.
Fig. 34. " " above ; $\frac{2}{1}$.
Fig. 35. *Ophioglypha Deshayesi*, below ; $\frac{2}{1}$.
Fig. 36. " " above ; $\frac{2}{1}$.
Fig. 37. " " arm-ioints ; $\frac{4}{1}$.
Fig. 38. " *confragosa*, above ; $\frac{3}{1}$.
Fig. 39. " " below, $\frac{3}{1}$.
Fig. 40. *Ophioplinthus medusa*, arm-joint ; $\frac{2}{1}$.
Fig. 41. *Ophioglypha intorta*, below ; $\frac{4}{1}$.
Fig. 42. " " above ; $\frac{4}{1}$.
Fig. 43. " " arm-joints ; $\frac{4}{1}$.
Fig. 44. " *brevispina*, below ; $\frac{3}{1}$.
Fig. 45. " " above ; $\frac{3}{1}$.
Fig. 46. " " arm-joints and comb ; $\frac{3}{1}$.
Fig. 47. " *ambigua*, arm-joints and comb ; $\frac{3}{1}$.
Fig. 48. " " below ; $\frac{3}{1}$.
Fig. 49. " *flagellata*, below ; $\frac{2}{1}$.
Fig. 50. " " above ; $\frac{2}{1}$. The disk-scales cannot be seen unless the specimen be dry.
Fig. 51. *Ophioglypha flagellata*, arm-joints ; $\frac{2}{1}$.
Fig. 52. " *ponderosa*, below ; $\frac{3}{2}$.
Fig. 53. " " above ; $\frac{3}{2}$.
Fig. 54. " " arm-joints ; $\frac{3}{2}$.
Fig. 55. " *jejuna*, below ; $\frac{6}{1}$.
Fig. 56. " " above ; $\frac{6}{1}$.
Fig. 57. " *confragosa*, arm-joints ; $\frac{3}{1}$.

PLATE III.

Fig. 58. *Ophioglypha Lacazei*, below ; $\frac{3}{1}$.
Fig. 59. " " above ; $\frac{3}{1}$.
Fig. 60. " " arm-joints ; $\frac{3}{1}$.
Fig. 61. " *undulata*, below ; $\frac{5}{2}$.
Fig. 62. " " above ; $\frac{5}{2}$.
Fig. 63. " *imbecillis*, below ; $\frac{4}{1}$.
Fig. 64. " " above ; $\frac{4}{1}$.
Fig. 65. " *radiata*, below ; $\frac{3}{1}$.
Fig. 66. " " above ; $\frac{3}{1}$.
Fig. 67. " *lapidaria*, below ; $\frac{3}{1}$.
Fig. 68. " " above ; $\frac{3}{1}$.
Fig. 69. " " arm-joints ; $\frac{3}{1}$.
Fig. 70. " *variabilis*, below, young ; $\frac{4}{1}$.
Fig. 71. " *lepida*, below ; $\frac{4}{1}$.
Fig. 72. " " above ; $\frac{4}{1}$.

Fig. 73. *Ophioglypha lepida*, arm-joints ; $\frac{4}{1}$.
Fig. 74. " *æqualis*, notch ; $\frac{4}{1}$.
Fig. 75. " " arm-joints ; $\frac{4}{1}$.
Fig. 76. " *ferruginea*, below ; $\frac{5}{1}$.
Fig. 77. " *Ljungmani*, above ; $\frac{3}{1}$.
Fig. 78. " *variabilis*, below ; $\frac{5}{1}$.
Fig. 79. " " above ; $\frac{5}{1}$.
Fig. 80. " *lienosa*, below ; $\frac{5}{2}$.
Fig. 81. " " above ; $\frac{5}{2}$.
Fig. 82. " " arm-joints ; $\frac{5}{2}$.
Fig. 83. " *convexa*, below ; $\frac{5}{2}$.
Fig. 84. " " above ; $\frac{5}{2}$.
Fig. 85. " *bullata*, Wyv. Thom., below ; $\frac{4}{1}$.
Fig. 86. " " " above ; $\frac{4}{1}$.

PLATE IV.

Fig. 87. *Ophioglypha elevata*, below ; $\frac{5}{1}$.
Fig. 88. " " above ; $\frac{5}{1}$.
Fig. 89. " " arm-joints ; $\frac{5}{1}$.
Fig. 90. " *rugosa*, below ; $\frac{4}{1}$.
Fig. 91. " " above ; $\frac{4}{1}$.
Fig. 92. " *costata*, below ; $\frac{5}{1}$.
Fig. 93. " " above ; $\frac{5}{1}$.
Fig. 94. " " arm-joints : $\frac{5}{1}$.
Fig. 95. " *albata*, below ; $\frac{3}{1}$.
Fig. 96. " " above ; $\frac{3}{1}$.
Fig. 97. " " arm-joints ; $\frac{3}{1}$.
Fig. 98. " *palliata*, below ; $\frac{3}{1}$.
Fig. 99. " " above ; $\frac{3}{1}$.
Fig. 100. " " arm-joints ; $\frac{3}{1}$.
Fig. 101. " *undata*, below ; $\frac{10}{1}$.
Fig. 102. " " above ; $\frac{10}{1}$.
Fig. 103. " *orbiculata*, below ; $\frac{5}{2}$.
Fig. 104. " " above ; $\frac{5}{2}$.
Fig. 105. " " arm-joints ; $\frac{5}{2}$.
Fig. 106. " *irrorata*, below ; $\frac{4}{1}$.
Fig. 107. " " above ; $\frac{4}{1}$.
Fig. 108. " " arm-joints ; $\frac{4}{1}$.
Fig. 109. " *Loveni*, below ; $\frac{3}{2}$.
Fig. 110. " " above ; $\frac{3}{2}$.
Fig. 111. " " arm-joints ; $\frac{3}{2}$.
Fig. 112. " *fraterna*, arm-joints ; $\frac{3}{2}$.
Fig. 113. " *ornata*, above ; $\frac{5}{2}$.
Fig. 114. " " arm-joints ; $\frac{5}{2}$.
Fig. 115. " *sculptilis*, below ; $\frac{3}{1}$.
Fig. 116. " " above ; $\frac{3}{1}$.

PLATE V.

Fig. 117. *Ophioglypha minuta*, below ; $\frac{6}{1}$.
Fig. 118. " " above ; $\frac{6}{1}$.
Fig. 119. " " arm-joints ; $\frac{6}{1}$.
Fig. 120. " *solida*, below ; $\frac{3}{1}$.
Fig. 121. " " above ; $\frac{3}{1}$.
Fig. 122. " " arm-joints ; $\frac{3}{1}$.
Fig. 123. " *inermis*, below ; $\frac{5}{2}$.
Fig. 124. " " above ; $\frac{5}{2}$.
Fig. 125. " " arm-joints ; $\frac{5}{2}$.
Fig. 126. *Ophiocten pallidum*, below ; $\frac{3}{1}$.
Fig. 127. " " above ; $\frac{3}{1}$.
Fig. 128. " " arm-joints ; $\frac{3}{1}$.
Fig. 129. " *amitinum*, below ; $\frac{5}{1}$.
Fig. 130. " " above ; $\frac{5}{1}$.
Fig. 131. " *umbraticum*, below ; $\frac{4}{1}$.
Fig. 132. " " above ; $\frac{4}{1}$.
Fig. 133. " *hastatum*, notch ; $\frac{3}{1}$.
Fig. 134. " " arm-joints ; $\frac{3}{1}$.
Fig. 135. *Ophiopyrgus Wyville-Thomsoni*, below ; $\frac{6}{1}$.
Fig. 136. " " " above ; $\frac{6}{1}$.
Fig. 137. " " " profile view ; $\frac{6}{1}$.
Fig. 138. *Ophiomusium Lütkeni*, below ; $\frac{3}{1}$.
Fig. 139. " " above ; $\frac{3}{1}$.
Fig. 140. " " arm-joints ; $\frac{3}{1}$.
Fig. 141. " *flabellum*, below ; $\frac{6}{1}$.
Fig. 142. " " above ; $\frac{6}{1}$.
Fig. 143. " " arm-joints and edge of disk ; $\frac{6}{1}$.
Fig. 144. " *pulchellum*, Wyv. Thom., below ; $\frac{5}{1}$.
Fig. 145. " " " " above ; $\frac{5}{1}$.

PLATE VI.

Fig. 147. *Ophiozona stellata*, below ; $\frac{4}{1}$.
Fig. 148. " " above ; $\frac{4}{1}$.
Fig. 149. " *insularia*, below ; $\frac{6}{1}$.
Fig. 150. " " above ; $\frac{6}{1}$.
Fig. 151. " " arm-joints ; $\frac{6}{1}$.
Fig. 152. " *antillarum*, below ; $\frac{4}{1}$.
Fig. 153. " " above ; $\frac{4}{1}$.
Fig. 154. " " arm-joints ; $\frac{4}{1}$.
Fig. 155. " *depressa*, below ; $\frac{7}{2}$.
Fig. 156. " " above ; $\frac{7}{2}$.
Fig. 157. " " arm-joints ; $\frac{7}{2}$.
Fig. 158. *Ophiotrochus panniculus*, below ; $\frac{5}{1}$.
Fig. 159. " " above ; $\frac{5}{1}$.

Fig. 160. *Ophiotrochus panniculus* arm-joints ; $\frac{5}{1}$.
Fig. 161. *Ophioceramis ? clausa*, below : $\frac{7}{1}$.
Fig. 162. " " above ; $\frac{7}{1}$.
Fig. 163. " " arm-joints ; $\frac{7}{1}$.
Fig. 164. " *? obstricta*, below ; $\frac{7}{1}$.
Fig. 165. " " above ; $\frac{7}{1}$.
Fig. 166. " " arm-joints ; $\frac{7}{1}$.
Fig. 167. *Ophiomastus tegulitius*, below ; $\frac{10}{1}$.
Fig. 168. " " above ; $\frac{10}{1}$.
Fig. 169. " " disk and arm in profile ; $\frac{10}{1}$.
Fig. 170. *Ophiernus vallincola*, below ; $\frac{4}{1}$.
Fig. 171. " " above ; $\frac{4}{1}$.
Fig. 172. " " arm-joints ; $\frac{4}{1}$.

PLATE VII.

Fig. 173. *Ophiopyren brevispinus*, below ; $\frac{9}{1}$.
Fig. 174. " " above ; $\frac{9}{1}$.
Fig. 175. " " arm-joints ; $\frac{9}{1}$.
Fig. 176. " *longispinus*, below ; $\frac{10}{1}$.
Fig. 177. " " above ; $\frac{10}{1}$.
Fig. 178. " " arm-joints ; $\frac{10}{1}$.
Fig. 179. *Ophiophyllum petilum*, below ; $\frac{6}{1}$.
Fig. 180. " " above ; $\frac{6}{1}$.
Fig. 181. " " arm-joints ; $\frac{6}{1}$.
Fig. 182. *Ophiochiton fastigatus*, below ; $\frac{2}{1}$.
Fig. 183. " " above ; $\frac{2}{1}$.
Fig. 184. *Ophioscolex dentatus*, below ; $\frac{5}{2}$.
Fig. 185. " " above ; $\frac{5}{2}$.
Fig. 186. " " arm-joints ; $\frac{5}{2}$.
Fig. 187. *Ophiogeron edentulus*, below ; $\frac{6}{1}$.
Fig. 188. " " above,; $\frac{6}{1}$.
Fig. 189. " " one spine ; $\frac{55}{1}$.
Fig. 190. *Ophioscolex tropicus*, below ; $\frac{4}{1}$.
Fig. 191. " " above ; $\frac{4}{1}$.
Fig. 192. " " arm-joints ; $\frac{4}{1}$.
Fig. 193. *Ophiosciasma attenuatum*, below ; $\frac{6}{1}$.
Fig. 194. " " above ; $\frac{6}{1}$.
Fig. 195. " " arm-joints ; $\frac{6}{1}$.
Fig. 196. *Ophiolebes scorteus*, below ; $\frac{5}{1}$.
Fig. 197. " " above ; $\frac{5}{1}$.

PLATE VIII.

Fig. 198. *Ophiobyrsa rudis*, below ; $\frac{3}{2}$.
Fig. 199. " " above ; $\frac{3}{2}$.
Fig. 200. " " arm-joints ; $\frac{3}{2}$.

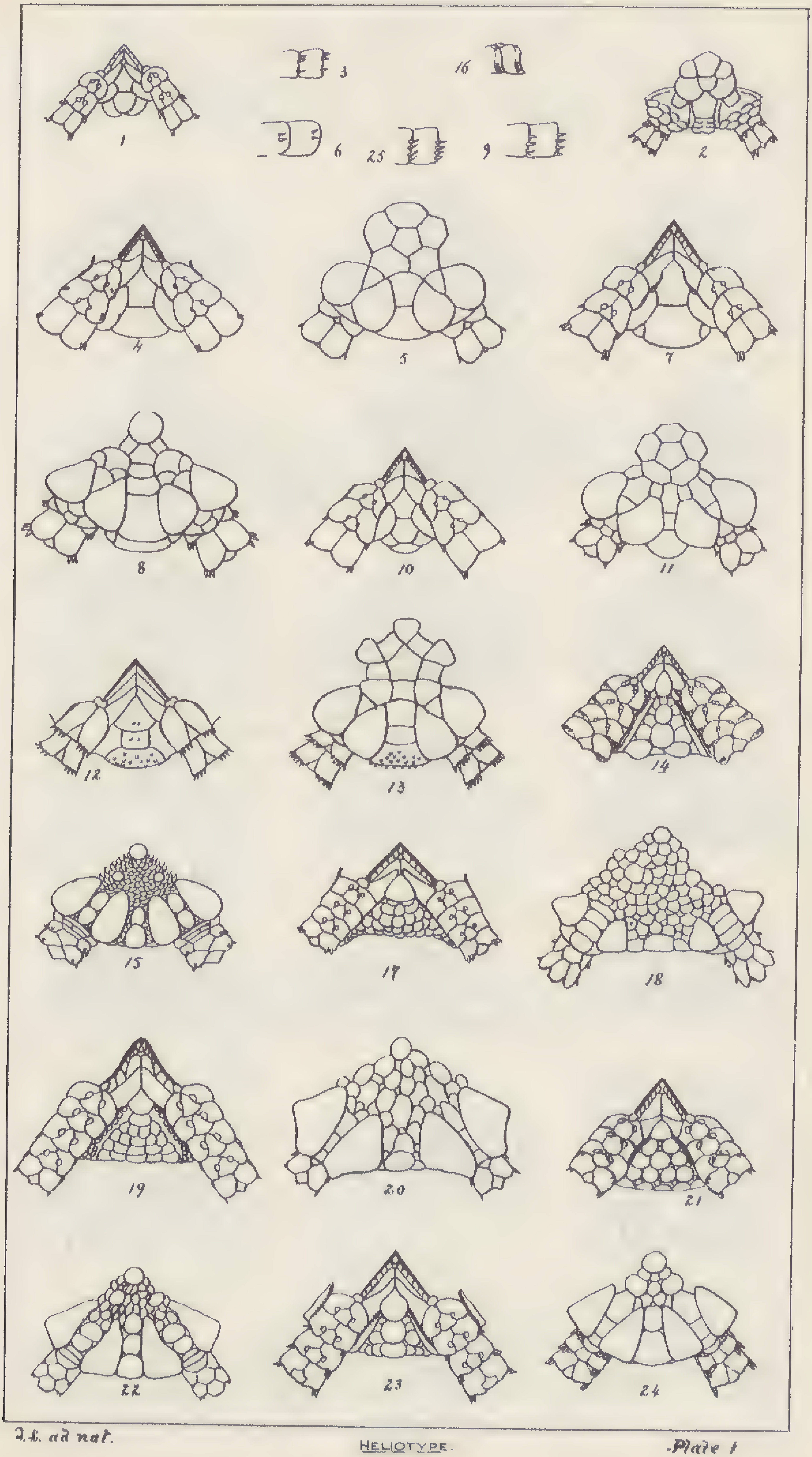
Fig. 201. *Ophiothamnus remotus*, below ; $\frac{10}{1}$.
Fig. 202. " " above ; $\frac{10}{1}$.
Fig. 203. " " arm-joints ; $\frac{10}{1}$.
Fig. 204. *Ophiacantha tuberculosa*, below ; $\frac{5}{1}$.
Fig. 205. " " above ; $\frac{5}{1}$.
Fig. 206. " *granulosa*, below ; $\frac{4}{1}$.
Fig. 207. " " above ; $\frac{4}{1}$.
Fig. 208. " " spine diagram ; $\frac{4}{1}$.
Fig. 209. *Ophiomitra plicata*, below ; $\frac{5}{2}$.
Fig. 210. " " above ; $\frac{5}{2}$.
Fig. 211. " " a single upper arm-spine ; $\frac{4}{1}$.
Fig. 212. " " spine diagram ; $\frac{5}{2}$.
Fig. 213. " *dipsacos*, below ; $\frac{7}{2}$.
Fig. 214. " " above ; $\frac{7}{2}$.
Fig. 215. " " spine diagram ; $\frac{7}{2}$.
Fig. 216. " *Sarsii*, below ; $\frac{3}{1}$.
Fig. 217. " " spine diagram ; $\frac{3}{1}$.
Fig. 218. *Ophiocamax vitrea*, below ; $\frac{5}{2}$.
Fig. 219. " " above ; $\frac{5}{2}$.
Fig. 220. " " spine diagram ; $\frac{3}{1}$.
Fig. 221. " " one spine ; $\frac{5}{2}$.

PLATE IX.

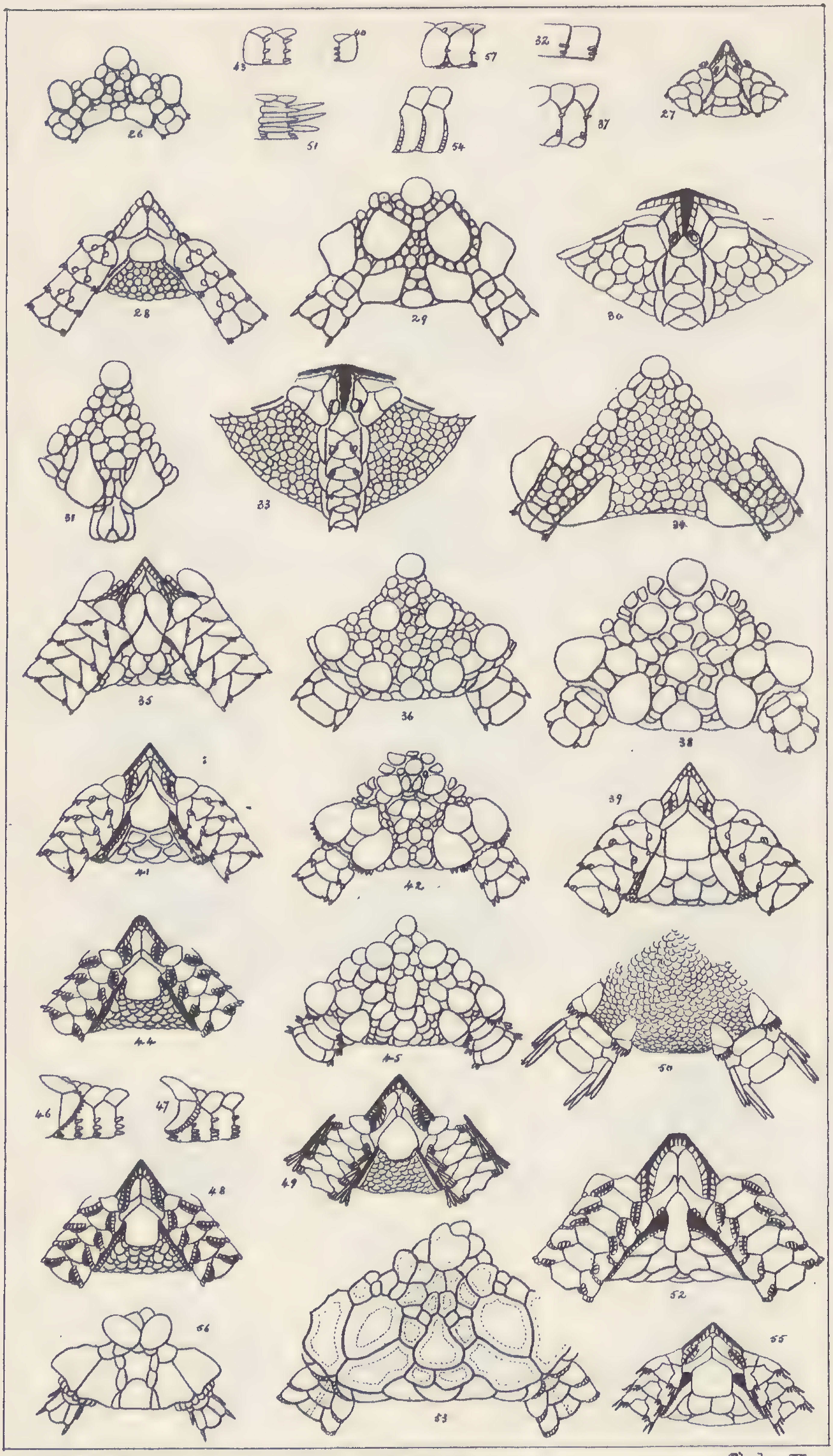
Fig. 222. *Ophiacantha Troscheli*, below ; $\frac{4}{1}$.
Fig. 223. " " above ; $\frac{4}{1}$.
Fig. 224. " " spine diagram ; $\frac{4}{1}$.
Fig. 225. " *stimulea*, below ; $\frac{4}{1}$.
Fig. 226. " " above ; $\frac{4}{1}$.
Fig. 227. " " spine diagram ; $\frac{4}{1}$.
Fig. 228. " " single disk-spine ; $\frac{15}{1}$.
Fig. 229. " *sentosa*, below ; $\frac{5}{2}$.
Fig. 230. " " above ; $\frac{5}{2}$.
Fig. 231. " " spine diagram ; $\frac{5}{2}$.
Fig. 232. " " disk-spines stripped of skin ; $\frac{10}{1}$.
Fig. 233. *Ophiomitra plicata*, (young) below ; $\frac{7}{2}$.
Fig. 234. " " " above ; $\frac{7}{2}$.
Fig. 235. " " " spine diagram ; $\frac{7}{2}$.
Fig. 236. " *carduus*, below ; $\frac{3}{1}$.
Fig. 237. " " above ; $\frac{3}{1}$.
Fig. 238. " " spine diagram ; $\frac{3}{1}$.
Fig. 239. " *chelys*, below ; $\frac{4}{1}$.
Fig. 240. " " above ; $\frac{4}{1}$.
Fig. 241. " " spine diagram ; $\frac{4}{1}$.
Fig. 242. *Ophiocamax vitrea*, (young) below ; $\frac{3}{1}$.
Fig. 243. " " " above ; $\frac{3}{1}$.
Fig. 244. " " " spine diagram ; $\frac{3}{1}$.

PLATE X.

Fig. 245. *Ophiacantha vepratica*, below ; $\frac{6}{1}$.
Fig. 246. " " above ; $\frac{6}{1}$.
Fig. 247. " " spine diagram ; $\frac{6}{1}$.
Fig. 248. " *cuspidata*, below ; $\frac{4}{1}$.
Fig. 249. " " above ; $\frac{5}{1}$.
Fig. 250. " " spine diagram ; $\frac{5}{1}$.
Fig. 251. " *cosmica*, below ; $\frac{2}{1}$.
Fig. 252. " " above ; $\frac{2}{1}$.
Fig. 253. " " spine diagram ; $\frac{2}{1}$.
Fig. 254. " " disk-spine ; $\frac{35}{1}$.
Fig. 255. *Ophiolebes vestitus*, below ; $\frac{4}{1}$.
Fig. 256. " " above ; $\frac{4}{1}$.
Fig. 257. " " arm-spine ; $\frac{8}{1}$.
Fig. 258. *Ophiacantha nodosa*, below ; $\frac{8}{1}$.
Fig. 259. " " above ; $\frac{8}{1}$.
Fig. 260. " " disk-spine stripped of skin ; $\frac{60}{1}$.
Fig. 261. " " an upper arm-spine ; $\frac{20}{1}$.
Fig. 262. " *cosmica*, spine diagram ; $\frac{3}{1}$.
Fig. 263. " " disk-spine ; $\frac{35}{1}$.
Fig. 264. " " spine diagram ; $\frac{3}{1}$.
Fig. 265. " " disk-spine ; $\frac{35}{1}$.
Fig. 266. " *cornuta*, arm-joints ; $\frac{7}{1}$.
Fig. 267. " *rosea*, arm-spines ; $\frac{4}{1}$.
Fig. 268. " " an under and a side arm-plate ; $\frac{4}{1}$.
Fig. 269. " *cosmica*, a mouth-angle ; $\frac{6}{1}$.
Fig. 270. " " arm-spine ; $\frac{10}{1}$.
Fig. 271. " *segesta*, arm-spines ; $\frac{10}{1}$.
Fig. 272. " *serrata*, arm-spines ; $\frac{5}{1}$.
Fig. 273. " " disk-grain ; much enlarged.
Fig. 274. " *longidens*, a mouth-angle and two under arm-plates ; $\frac{10}{1}$.
Fig. 275. " *imago*, arm-spines ; $\frac{4}{1}$.
Fig. 276. " " disk-grain ; $\frac{10}{1}$.
Fig. 277. " *levispina*, arm-joint ; $\frac{5}{1}$.



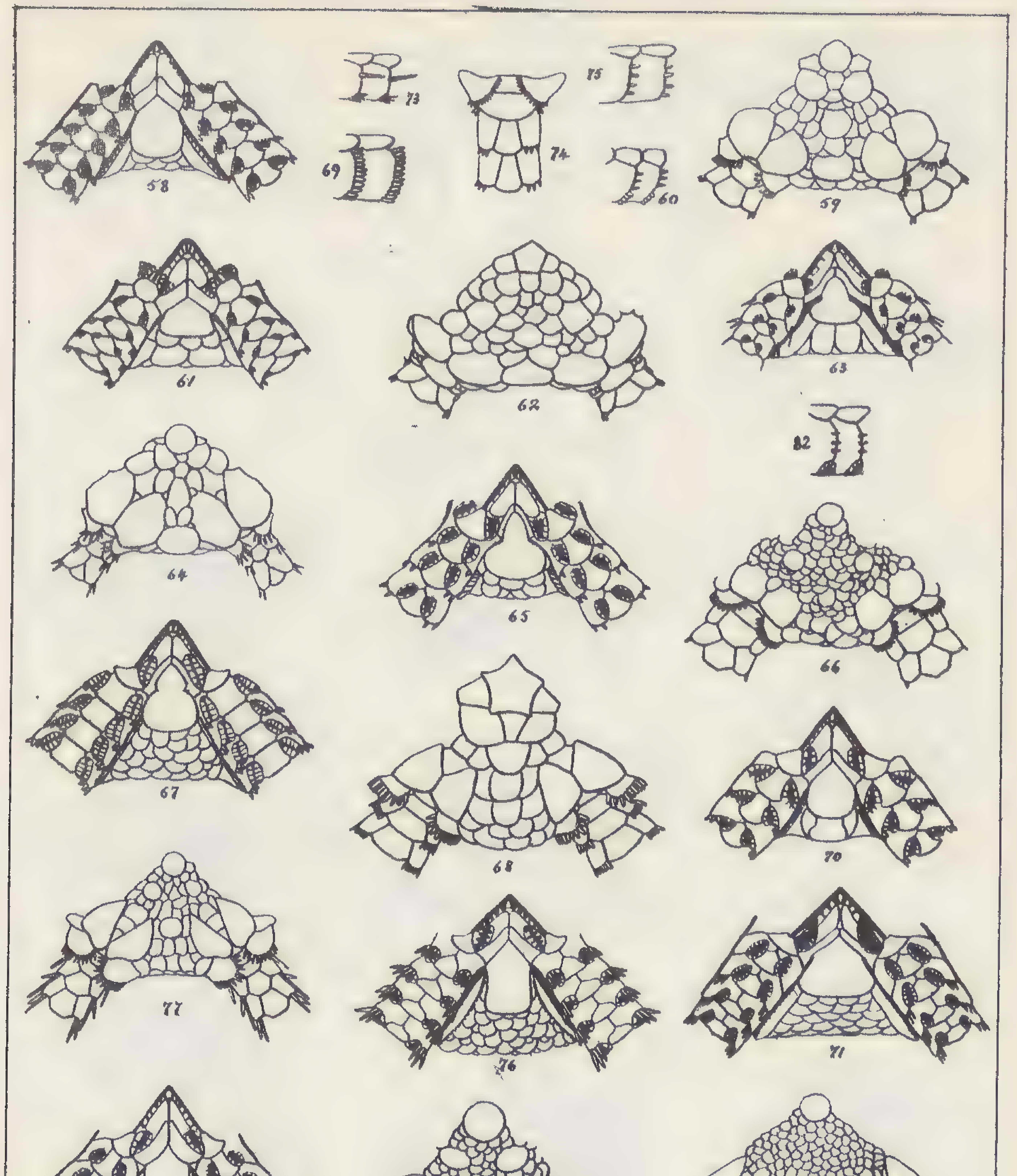
J. L. ad nat. HELIOTYPE. Plate I



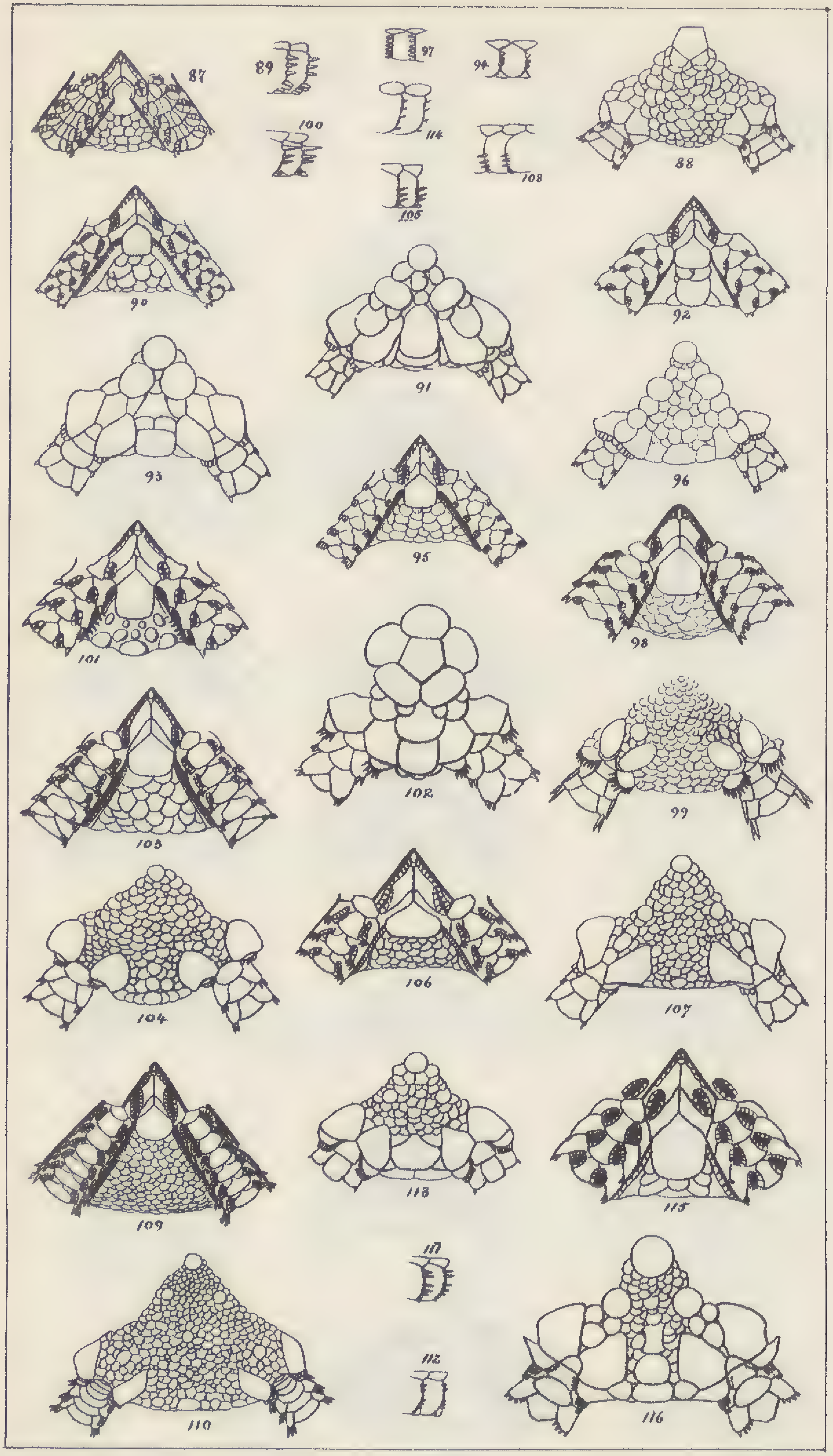
T. L. ad nat.

HELIOTYPE

Plate II



J. L. ad nat. HELIOTYPE Plate III



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HELIOTYPE

Plate IV

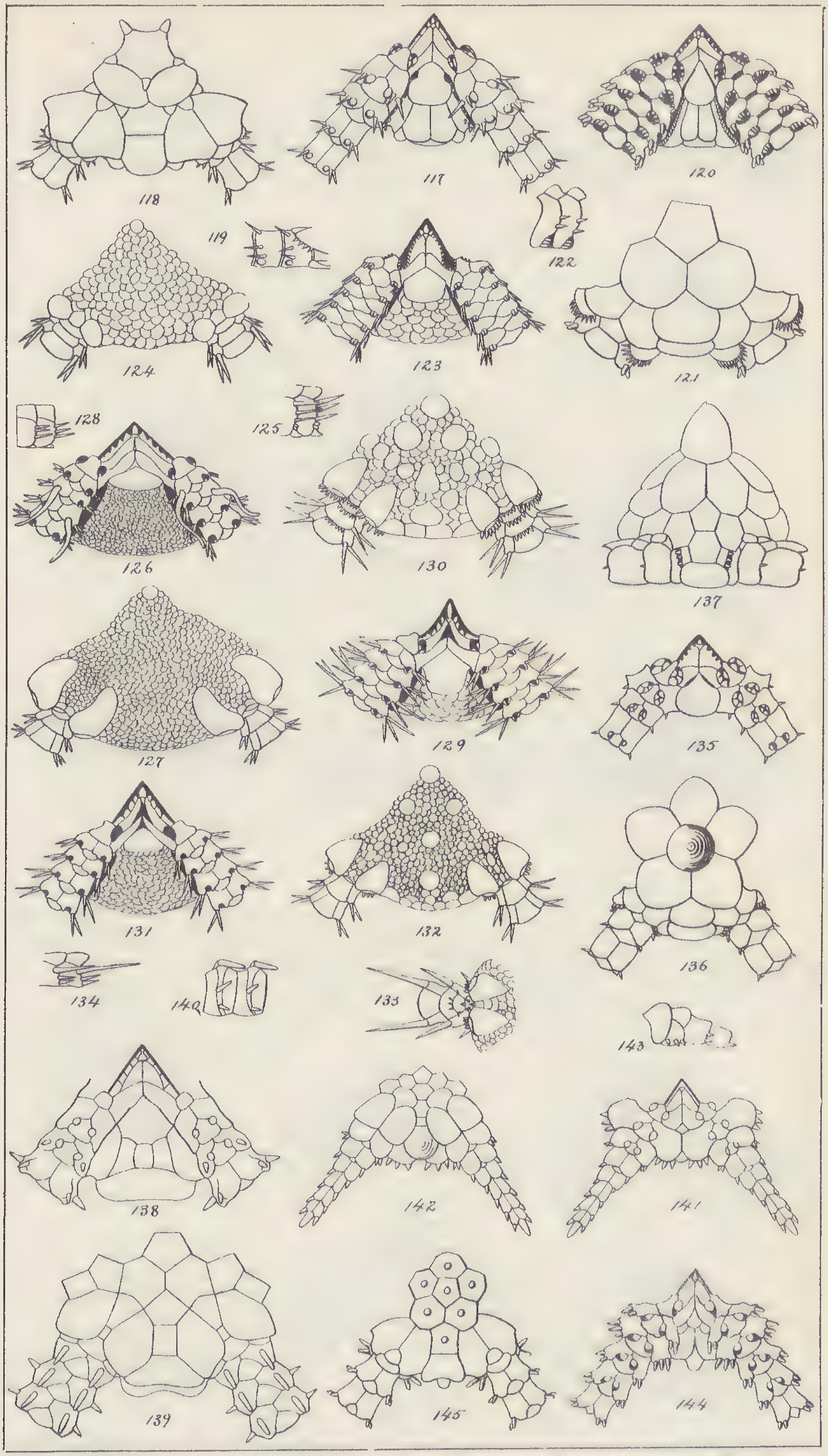

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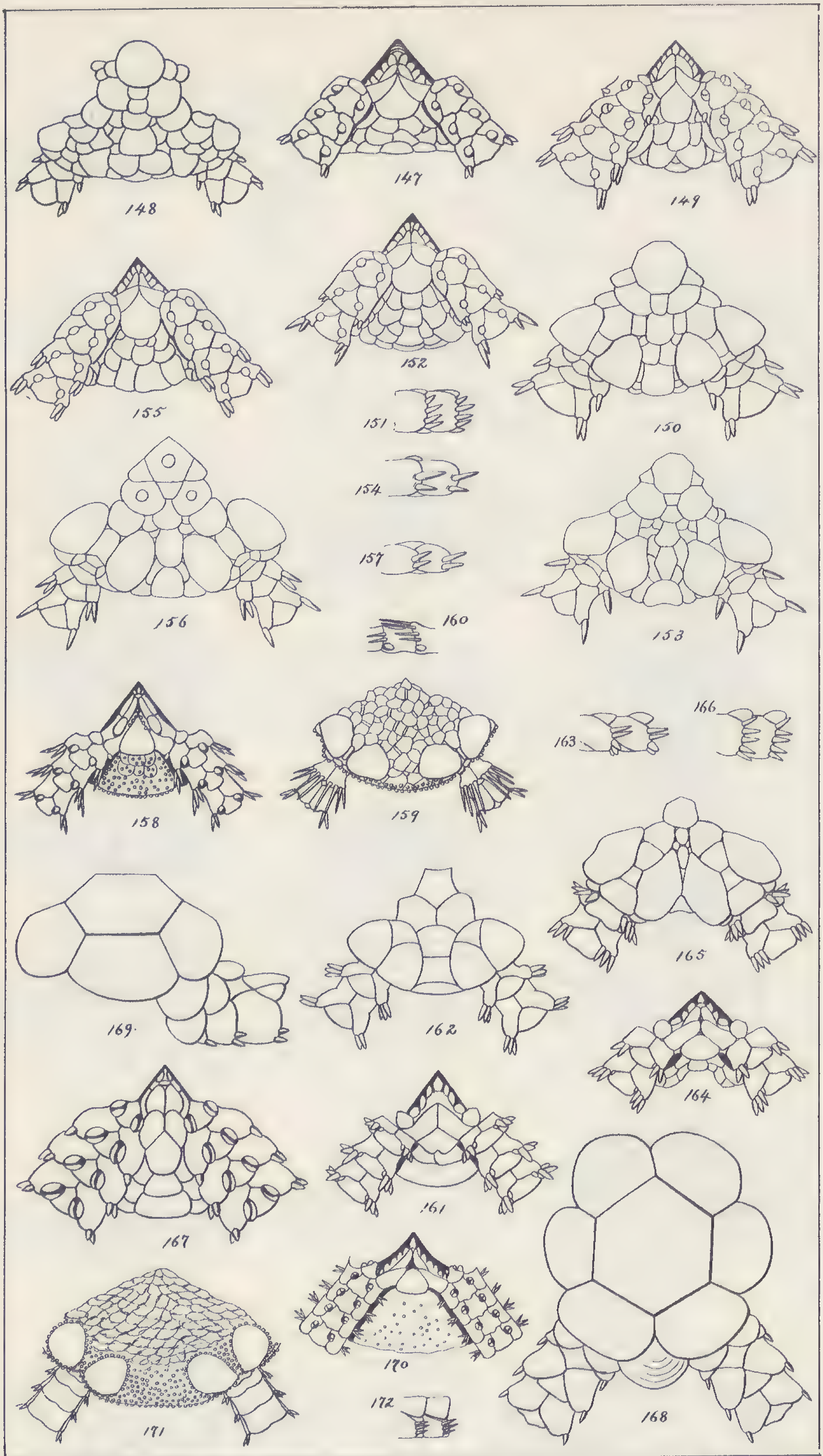
Plate V.

THE HELIOTYPE PRINTING CO. 220 DEVONSHIRE ST. BOSTON



T. L ad nat

Plate VI.

THE HELIOTYPE PRINTING CO 220 DEVONSHIRE ST BOSTON

T. L. ad nat.

Plate VII

THE HELIOTYPE PRINTING CO. 220 DEVONSHIRE ST. BOSTON

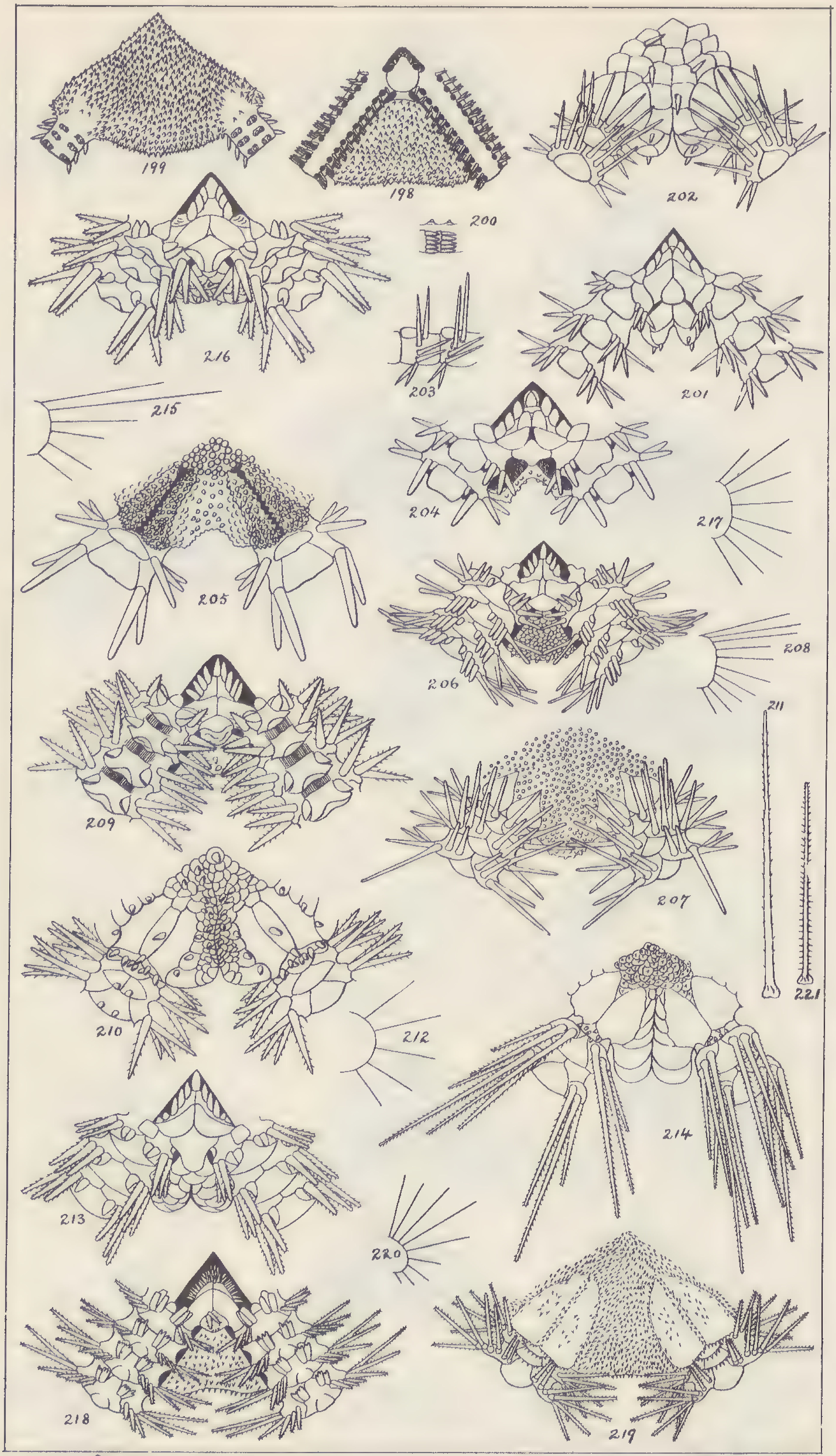


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Plate VIII.

THE HELIOTYPE PRINTING CO 220 DEVONSHIRE ST BOSTON

T.L. ad nat.

Plate IX

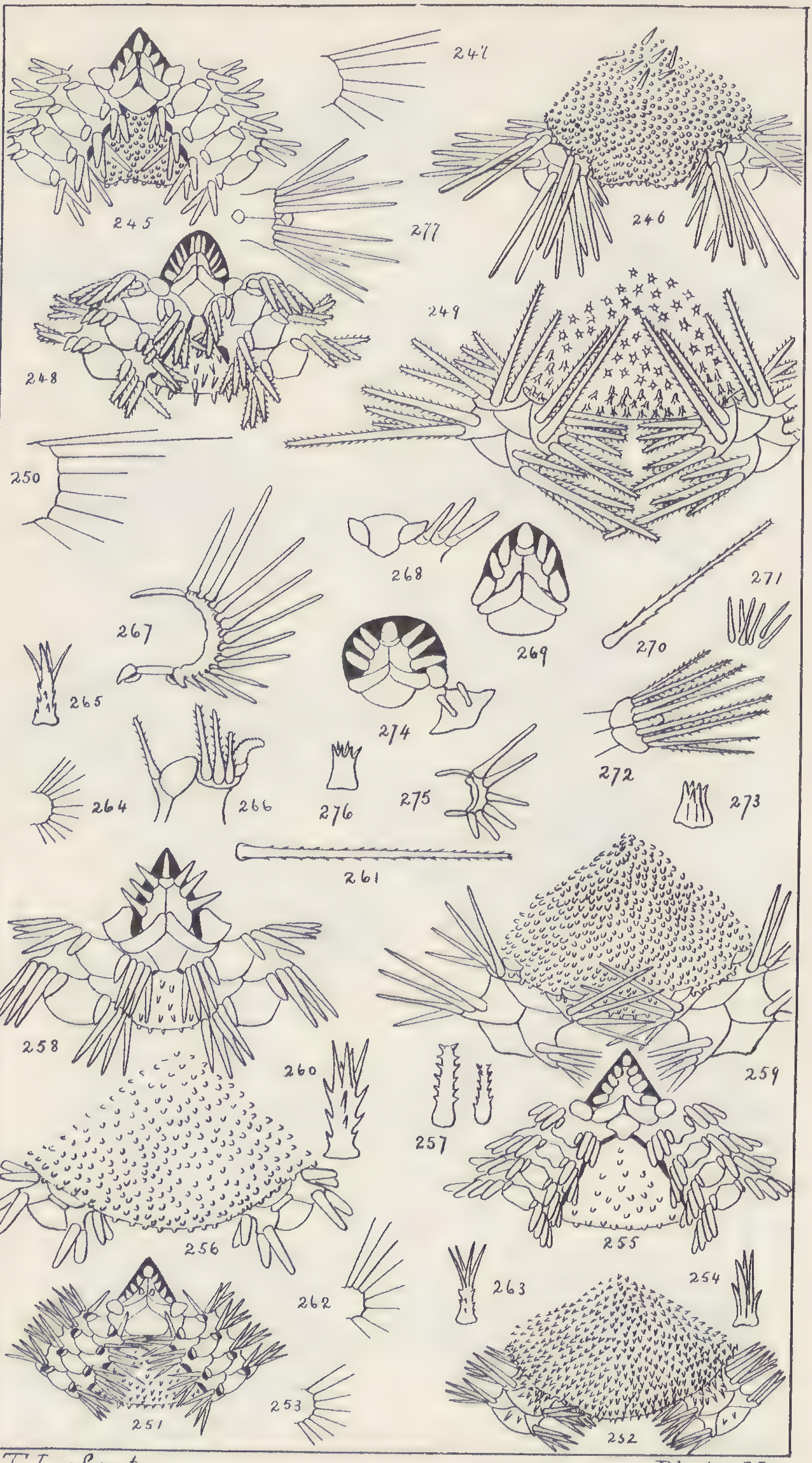

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Plate X.

THE HELIOTYPE PRINTING CO. 220 DEVONSHIRE ST BOSTON

By an unfortunate oversight in Bulletin Mus. Comp. Zoöl., Vol. V., No. 8, the paper of Sir William Thomson was omitted. It is as follows, and should have been inserted after the introductory remarks in the first paragraph of the first page ending "I quote his own words to explain its action": —

"A measured resistance is applied systematically to the wheel, always more than enough to balance the weight of wire out. The only failure in deep-sea soundings with piano-forte wire, hitherto made, has been owing to neglect of this essential condition. The rule adopted in practice is to apply resistance, always exceeding by ten pounds the weight of the wire out. Then the sinker being 34 pounds, we have 24 pounds weight left for a moving force. That, I have found, is amply sufficient to give a very rapid descent, — a descent so rapid that in the course of half an hour or fifty minutes the bottom will be reached at a depth of 2,000 or 3,000 fathoms. The person in charge watches a counter, and for every 250 fathoms (that is, every 250 turns of the wheel) he adds such weight to the brake-cord as shall add 3 pounds to the force with which the sounding-wheel resists the egress of the wire. That makes 12 pounds added to the brake resistance for every 1,000 fathoms of wire run out. The weight of every 1,000 fathoms of the wire in the air is 14½ pounds. In water, therefore, the weight is about 12 pounds; so that, if the weight is added at the rate I have indicated, the rule stated will be fulfilled. So it is arranged that when the 34 pounds weight reaches the bottom, instead of there being a pull, or a moving force, of 24 pounds on the wire tending to draw it through the water, there will suddenly come to be a resistance of 10 pounds against its motion. A slight running on of the wheel, — one turn at the most, — and the motion is stopped."

No. 8. — *Reports on the Results of Dredging, under the Supervision of* Alexander Agassiz, *in the Gulf of Mexico, by the United States Coast Survey Steamer "Blake,"* Lieutenant-Commander C. D. Sigsbee, U. S. N., Commanding.

(Printed with the consent of C. P. Patterson, Superintendent U. S. C. S.)

I.

Description of the Sounding-Machine, Water-Bottle, and Detacher used on board the "Blake" by Lieutenant-Commander C. D. Sigsbee, U. S. N., *Assistant U. S. Coast Survey.*

U. S. Coast Survey Steamer "Blake."

Hon. C. P. Patterson, *Superintendent of the Coast Survey.*

Dear Sir, — Several years ago Sir William Thomson invented a machine for deep-sea sounding by wire, and I quote his own words to explain its action : —

Captain George E. Belknap, U. S. Navy, while commanding the U. S. S. "Tuscarora," during her operations in the Pacific Ocean, in 1873, was the first to thoroughly test the machine in general use. I had the honor to read the reports made by him to the Bureau of Navigation, Navy Department, detailing the working of the sounding apparatus. While it was evident that the machine for soundings by means of wire gave remarkable results as compared with rope soundings, its success was apparently due in a great degree to the intelligence, patience, and skill of Captain Belknap and the officers who assisted him. My study of the reports suggested the idea of trying to improve the machine, in order that it might be worked with fewer demands on the watchfulness and ingenuity of those having charge of it. Captain Belknap had always been forced to reel in the wire by hand, and one of the plans that presented itself to me was to interpose an accumulator on the wire, between the reel and the sinker, which by showing the strain on the wire at all times while reeling in, and by easing the sudden jerks on the wire caused by the motion of the ship, would allow of reeling in by steam. Under instructions from you I commenced, in the summer of 1874, designing a machine intended to carry out my views, and as the drawings advanced

other ideas were incorporated with the original plan. From the drawings a machine for experimental purposes was made in the winter of 1874 – 5. The new machine was used for three years on board the Coast Survey Steamer "Blake," the vessel being under my command, and engaged in deep-sea work. As we had previously used the original machine for six months, opportunity was had of comparing the relative merits of the two machines. Some faults, arising from bad mechanical arrangements, had first to be rectified in the new machine, after which, even under the most unfavorable circumstances of wind, sea, and current, it performed as I had wished. In the first form of Sir William Thomson's machine, or rather in its somewhat modified form as used by Captain Belknap, there was simply the reel and register, as shown in my drawings, and in the rear of the reel a small pulley connected tangentically with a scale. Over the friction score of the reel, and thence around the score of the pulley, a single part of an endless friction line was taken, and the scales showed the amount of resistance applied to the reel while the sinker was descending. The wire was payed out directly from the reel into the water. (See the appended sketch, copied from Captain Belknap's book.) To a later form of his machine the inventor had added a reeling-in pulley and a swivel or castor pulley, both of which are improvements, and have been adopted by me in designing a new machine. His pulleys are of different construction and arrangement from those shown in my drawing, but in both cases they serve the same purpose. (See Sir William Thomson's pamphlet on the subject of his machine.) The improvements which I have endeavored to effect lie chiefly in the employment of a peculiar kind of accumulator, and its adaptation to the various uses of accumulator, dynamometer, brake, correct register, and governor.

I think I may state, after four years of experience in deep-sea sounding with wire, in a small steamer, that the value of the improvements warrant their extra cost; and I would offer the results accomplished as evidence of the correctness of my assumption.

In reeling in, the new machine has the advantage at all times. In paying out, in perfectly calm weather there is little advantage gained over the old machine; but when there is any motion to the vessel the gain is very great for the new machine, while in ease of manipulation the advantage is always most decidedly in favor of the latter.

With the experimental machine between twelve and fifteen hundred soundings have been taken, the original springs being still in use, and no repairs having been necessary in any part of the apparatus.

Having, therefore, tested the value of the improvements, it only remained for me to put them in a better mechanical shape, and I therefore submit the accompanying drawings, which have been withheld for the past two years that any slight idea occurring to me might be embraced in the general plan.

Description of the Parts of the Machine.

The Reel (*A*, Figs. I., II., III., IV., V.) should be, for convenience, one fathom in circumference of drum, and should have a friction score which is V-shaped in cross section. When the sinker strikes the bottom, the momentum of the reel and its remaining wire requires to be quickly overcome by the resistance of the friction line, in order that any undue slacking and consequent kinking of the wire may be avoided. To secure this quick stoppage, the reel should be made as light as the very considerable strength required for reeling in will permit. In reeling in without the reeling-in or strain pulley, it is necessary that the reel should be of sufficient strength to resist the accumulated strain of successive convolutions of the wire under strong tension. If a reel can be made of light weight and yet capable of bearing this crushing force when reeling in from great depths, the strain pulley for reeling in will no longer be needed. The reel should be made of iron or steel, as a brass reel enwrapped with steel wire would perhaps cause the deterioration of the wire through the effects of galvanic action. It is rigidly attached to its axle by a key, and the easy removal of the key would be a convenience, since the reel without its axle could be stowed into a much smaller tank than is necessary when the axle is retained. When a reel containing wire is out of use it is generally kept in a tank of oil. A crank should be provided for each end of the axle.

The Register (*B*, Fig. I.). — The construction of this is sufficiently explained by the drawing. It is the same as that used by Sir William Thomson, and is worked by a screw-thread attached to the axle of the reel. The register evidently does not record *fathoms*, an interpolation being necessary in determining, from the reading of the register, the length of wire payed out. It is very handy, however, in keeping an approximate account of the wire payed off the reel, so that the correct amount of resistance can be applied to the reel. The correction to add to the reading of the register is so easily found after the manner followed on board the "Blake," that the register is desirable also as a check on the odometer.

The Reeling-in or Strain Pulley (*C*, *D*, *E*, Figs. I., IV., V.) is com-

posed of three separate pulleys, *C*, *D*, and *E*,—the score *E* for the wire; the score *C* for a connecting rubber or rope band with the friction score of the reel, if desired; and the score *D* for an endless rope band connecting with the hoisting-engine.

The Accumulator is composed of the tubes *F*, *F*, *F*, and *C* (Figs. I., II., III., IV., V.), containing the spiral springs *G*, *G* (Fig. III., 31 inches long, 2½ inches outside diameter, 4 feet movement for 150 lbs. strain directly applied), connected with movable cross-head *H* (Figs. II., VII., VIII., IX.) by means of the chain (or wire rope) *I*, *I* (Figs. I., II., III.), which pass over the pulleys *J*, *J* (Figs. I., II., XII.). Each tube is in three sections, the upper section being 2½ inches inside diameter, and ⅛ inch in thickness; and the lower sections 2½ inches inside diameter, and ¼ inch thick. The tubes are hinged at *K*, *K* (Figs. I., II., III., IV.), so that the upper sections may be lowered for convenient stowage. They are graduated for the number of pounds pull on the wire, the upper arm of the cross-head being the index. The lower section of each tube unscrews for stowage. The cross-head *H*, containing the pulley *L* (Figs. I., VII., VIII., IX.), moves on the guides *M*, *M* (Figs. II., III., V., XI.), which are screwed to the tubes. The pulley *L* is rigidly attached to its axle by a key. To the axle is attached an odometer, *N* (Fig. II.). The pulley is exactly one yard (½ fathom) in circumference on the face, less the allowance for thickness of wire. One half the number of revolutions shown by the odometer will therefore give the number of fathoms of wire payed out or reeled in. Both pulley and cross-head should be made as light as strength will admit (gum metal would probably be the best material for them), since the momentum which they acquire during the plunges of the vessel must be overcome before the cross-head can respond to the reactionary impulse of the springs; also, because it is desirable that very little of the extension of the springs should be taken up by the weight of the cross-head and pulley. As much as possible of this extension should be reserved for sustaining the pull of the wire in reeling in. Again, it is probable that a very heavy cross-head needs to be counterbalanced. The combined weight of the springs is 16½ lbs., and if the weight of the cross-head and pulley approximates to that amount, the weight of the springs will act as a counterbalance. There will be very little lateral strain on the cross-head other than that due to its own weight while the ship is heeled. *O*, *O* (Figs. II., VII., VIII.) are shoulders to guard against the bending of the cross-head in case of parting the chains *I*, *I*, or of parting the wire. Should the chains part, the cross-head would fall, the lower

shoulders striking on the props *P*, *P* (Figs. II., III., V.). Should the wire part while reeling in, the cross-head, on flying up, would receive the blow against the upper shoulders, the latter striking against the cross-piece upon which rest the pulleys *J*, *J*. On the experimental machine a piece of rubber was fastened under the cross-piece to ease the shock. It was also our practice sometimes in reeling in to knot the two parts of the friction line somewhere near the bottom of the guides, leaving it still rove through the small pulley *Q* (Figs. II., VII., VIII., IX.). In the latter case, if the wire parted, the friction line would prevent the cross-head striking the cross-piece. The tubes are graduated to 150 lbs., beyond which it is not safe to expose the wire in general use; it being presumed that in every very long length of wire there may be some weak spots. By the arrangement shown in the drawing, the cross-head pulley can be unshipped without removing the cross-head from between the guides. Should it be found that the wire has a tendency to fly off the cross-head pulley (something not likely to occur, excepting when reeling out slack wire to detach the sinker, after the latter is on bottom), a suggestion for preventing such an accident is shown in Figs. VII., IX.

The Swivel Pulley. — The object of this pulley, *S* (Figs. I., II., V.), is to allow of the wire being reeled in while the vessel is steaming ahead. A steel sleeve fastened to the bed-board by bolts has a brass collar, to which is bolted the arm holding the pulley! In the positions shown in Figs. I., V., the pulley is ready for reeling in, and it can be swung laterally to any desired angle. The score will always be in the same line with the score of the cross-head pulley. Before paying out the wire, — or before reeling-in, if it be not intended to steam ahead during the operation, — the arm *T* which holds the swivel pulley is released from the bolt *U*, when it will pivot on the bolt *V*. The pulley should then be lifted clear of the wire, and turned to one side and secured.

The Scales (*W*, *X*, Fig. IV.). — They should be of the kind that have a long movement of the pointer for a slight extension of the springs in the scales. In the manner of bending the friction rope to them, as shown in the drawing, they would perhaps "slew" so as not to present the faces of the scales in the same plane. It would therefore be better to use braided rope ($\frac{1}{4}$ inch in diameter), and any seaman could bend on the line to suit the circumstances of the case. In paying out the wire the difference between the readings of the scales *X* and *W* will be the number of pounds of resistance applied to the reel by the friction rope.

Wire and Stray Line. — The wire to be used is the same as that rec-

ommended by Sir William Thomson, namely, steel piano-forte wire, No. 22, Birmingham gauge, weighing 14½ lbs. to the nautical mile. The friction line should be ¼ inch or slightly less in diameter, and should be oiled or kept wet with water where it comes in contact with the friction score of the reel.

To take a Sounding with the Machine.

The reel, containing the wire and stray line, being in its bearings, reeve the end of the stray line up over the cross-head pulley, from inboard to outboard, and then down through the guide which forms part of the attachment of the swivel pulley. Bend on the end of the sounding-rod. Ship the pawl into the ratchet-wheel, which is on the axle of the reel. Place the friction line over the friction score, as shown in the figure, and from the scales reeve it under the pulley *Y*, on the same side of the machine as the friction score, then up and over the pulley *Q*, and down under the other pulley *Y* (Figs. I., III., V.). Haul the cross-head well down on the guides, against the resistance of the accumulator springs *G*, *G* (Fig. II.), so as to insure a large surplus of friction on the reel at the time of starting the sounding. Make fast the hauling part of the friction line to the cleat *Z* (Figs. I., IV., V.). Connect the sinker with the sounding-rod, and get it overboard, letting the stray line take the whole weight. See that the register and odometer are properly set. Attend the friction line, throw back the pawl, and let the reel revolve slowly until assured that everything is working well, when ease up the friction line and follow out as nearly as practicable the rule governing the amount of resistance to be applied to the reel. If a weight has been attached to the stray line to prevent the kinking of the wire, be particularly careful not to let the reel revolve fast until this weight is through the guide. Avoid any stoppage just as the end of the wire is leaving the reel, as it is not prudent to subject a very short length of wire to the torsion that may be caused by the spinning around of the sinker in the water. It is impossible to say how fast the wire may be allowed to pay out, since the limit of safety varies with circumstances, and depends on the state of the sea and the extent and rapidity of the ship's rolling and pitching motions. The drawback to quick work with the original machine lies in the tendency of the wire to fly off the reel — and kink or break — during the downward plunges or rolls of the ship. The strain at such times is very much relieved from the wire; and, in a moderately heavy sea, should the reel be revolving fast, it is sometimes not slowed down in time to prevent the

wire from paying out faster than its own weight can take it off the reel. The action of the new machine has the effect of a governor on the motions of the reel, which can be explained as follows: If the ship plunge or roll downward, the strain is relieved from the wire, and the consequent effort of the cross-head to rise is transferred to the friction line. Thus more resistance is automatically placed upon the reel, checking its speed or stopping it altogether, — rarely the latter, — until the rising of the vessel or the slowing down of the reel causes an increased strain on the wire. As the strain increases the cross-head is borne down, which again eases the friction line, allowing the reel to revolve more rapidly. In general terms, then, if the tension of the wire increases the tension of the friction rope diminishes, and *vice versa.* When the vessel is quiet the accumulator has no inherent effect in changing the amount of resistance on the reel. This alternating movement of the cross-head when paying out is scarcely perceptible to the eye, and the motions of the reel were found to be not fitful, but remarkably *smooth.*

With the original machine, when the sinker strikes bottom the weight of the sinker ceases to act as a moving force for the reel, and if a resistance slightly in excess of the weight of the wire payed out has been placed upon the reel, the latter will stop. In the same case with the new machine, the weight of the sinker not only ceases to act as a moving force for the reel, but the force, due to the weight of the sinker, is automatically transferred to the friction line thus: the cross-head, being freed from the bearing-down effort of the weight of the sinker, rises and communicates that effort to the friction line. This peculiarity of the new machine may not appear to give any great advantage over the original machine; but, since it is a safeguard, and results, without extra costs, from the action of such parts of the machinery as are devised for other and more necessary purposes, it may be considered a good point in the working of the apparatus.

As soon as the sinker strikes bottom, which is made apparent by the stopping of the reel, read the register and the odometer, and at the same time ship the crank on the axles of the reel. Throw the bight of the friction line out of the friction score, and, to insure the detachment of the sinker, pay out, if necessary, a few turns of the wire by hand until the wire feels slack. Then reel in a few turns cautiously, and the distance that the cross-head travels down its guides will indicate whether the sinker has been detached. Generally, with a good form of detacher, it drops off on striking bottom. Avoid slacking the wire more than is necessary. It is well to keep a record of the time occupied by the reel

in making each one hundred turns during soundings, — noting the state of the sea, etc., — as the best way to gain a knowledge of the rate at which it is safe to let the wire pay out under different circumstances. In a smooth sea there will be very little trouble, and probably with the new machine there will be none in the heaviest sea in which soundings can be taken; but sounding with wire having a tensile strength of 240 lbs. is a delicate operation even with the best apparatus, and the person in charge, should he lack experience in sounding with wire, would do well to keep, at first, well within the bounds of safety, and then to approach gradually the limit of theoretical possibilities. If everything is working well and the wire keeping taut at all times, it is of course safe if the correct amount of resistance has been applied to the reel according to the rule.

Sounding-Rod, composed of Sigsbee's Detacher used in connection with a modification of Captain Belknap's Cylinder No. 2.

Description of Parts.

A cylinder, *a*, with screw-joint at *B*.

A casting composed of the cylindrical guides *C*, *C* and the perforated plate *J*.

The valve seat *E*.

The popper-valve *F*, connected rigidly to the pipe *G*, which slides freely on the lower guide *C*.

The weak spiral spring *H*.

The hollow cone *I*, to the bottom of which is soldered the smooth cylindrical plate *D*.

A detacher composed of the swivel *K*, the pawl *L*, the tumbler *M*, and the spring *N* (No. 14 American-gauge brass spring wire).

The perforations *P*, *P*, etc., for the escape of water.

In connection with the above is used the iron shot-sinker *Q*, fitted with the iron wire bail *R*.

Working.

During the descent the cone *I* is kept up by the shot as shown in Figs. I. and II., and on striking bottom the bail is prevented from getting over the top of the detacher by the bearing which the sinker has against the under part of the cone.

When the sinker strikes bottom the slacking of the sounding line or wire trips the tumbler, and the sinker is free to slide off the cylinder.

This tumbler is kept back by the spring *N*, and the bail cannot be re-hooked when the line is hauled taut to reel in.

The resistance of the bottom soil raises the poppet-valve *F*, and the specimen of soil enters the cylinder, the water within the cylinder being free to escape through the various perforations *P*, *P*, etc.

On hauling back, the poppet-valve falls, or is forced by its spring, *H*, to the valve-seat, and the cone falls, closing the water apertures. When the rod has been got on deck the lower part of the cylinder is unscrewed, when the specimen of soil may be extracted.

The poppet-valve arrangement is Captain Belknap's, but I have taken the liberty of employing it somewhat differently from his method. The water-valve arrangement I have also changed, for certain reasons of convenience, etc.

Sigsbee Water Specimen Cup.

Description of Parts.

The cylinder *A*.

The lower valve-seat *B*, which screws to the cylinder by a right-handed thread.

The detachable upper-valve seat *C*, detachable to allow the removal of the upper valve for cleaning.

The upper and lower poppet-valves *D* and *E*, connected by a rod of spring brass wire, and adjustable by a fine screw-thread at *F*.

A small brass compression spring at *G*, to prevent a too easy disadjustment of the valves.

The framework *H*, fastened to the cylinder with a left-handed screw-thread, enclosing the upper valve-seat.

The German-silver removable sleeve *I*.

The brass pin *J*.

The German-silver shaft *K*, with right-handed screw-thread (44 to the inch) at *L* and *M*.

A German-silver propeller, composed of two bent blades *N*, *N*; the hub *O*; the inside screw-thread *P* (44 to the inch); the cap *Q*, removable, but fitting tight on the hub; and the bevelled lugs *R*, *R*.

The German-silver bouching *S*.

A German-silver screw-cap with milled head, *T*, *T*; bevelled slots, *U*, *U*; and inside screw-thread *V*.

A clamp composed of the two lugs, *W*, *W*; the pivot screw *X*; and the steel spring wire *Y*.

Working.

The cup comes to the surface filled with water, the screw-cap down on the upper valve, and the propeller resting on the cap. To get the water out, first screw up the propeller until it takes on the thread of the shaft; then screw up the screw-cap until it uncouples from its thread. The valves may then be raised and the water discharged.

After the screw-cap has been uncoupled the cup is automatic in its working, and it is only necessary to clamp it on the line with the spring clamp *Y*. Before paying out the propeller may be screwed up to its full extent, but this is not necessary.

As the cup descends the resistance of the water raises the valves, and also screws up the propeller until the lower thread in the hub clears the upper thread on the shaft, when the propeller uncouples and revolves freely on the shaft, where it is guided at top and bottom, which prevents chafe on the thread.

Should a stoppage then be made to fasten on another cup, the propeller will not screw down by the rolling or pitching of the vessel.

It will be noticed that the blades are bent on their upper edge. With the blades thus bent, and the propeller made very light, it has been found, experimentally, that by rising and falling equal distances through the water the propeller will screw up instead of down. Without bending the propeller blades, it is evident that the propeller would gradually screw down by a rising and falling motion, since its weight would assist its screwing down and resist its screwing up; but, even thus, experiments have shown that for an alternating motion through the water, continued for a longer time than any probable stoppage, the propeller would screw down only about a quarter of an inch, which is much within the margin of safety; and, on relowering, the propeller, in that case, would again rise and uncouple. However, the bending of the blades overcomes any bad effects from the motion of the vessel, and the valves are free to open during the whole descent without regard to the number of stoppages made.

At any stoppage each cup has within its cylinder a specimen of the water from the place where it stops.

On hauling in, the propeller of each cup screws down, by the resistance of the water, until the upper thread of the hub clears the lower thread of the corresponding screw on the shaft, when the propeller drops on the screw-cap, — which until that time has been at rest, — the lugs *R*, *R* clutch into the slots *U*, *U*, and the screw-cap is screwed down until it touches the upper valve, which keeps both valves closed. It is evident

that the screw-cap can be got out of this second position only by hand, for the lugs and slots are bevelled, and the lugs can clutch the screw-cap only in one direction. The resistance of the water which would reverse the propeller at a stoppage on the ascent would also lift the propeller clear of the screw-cap. If each propeller were regulated to close down the screw-cap in passing through equal distances in water, each cup would be locked when the cup had passed through that distance after the commencement of the ascent. The screw-cap is found screwed down so tight in coming out of the water that it can be set no tighter without endangering the thread.

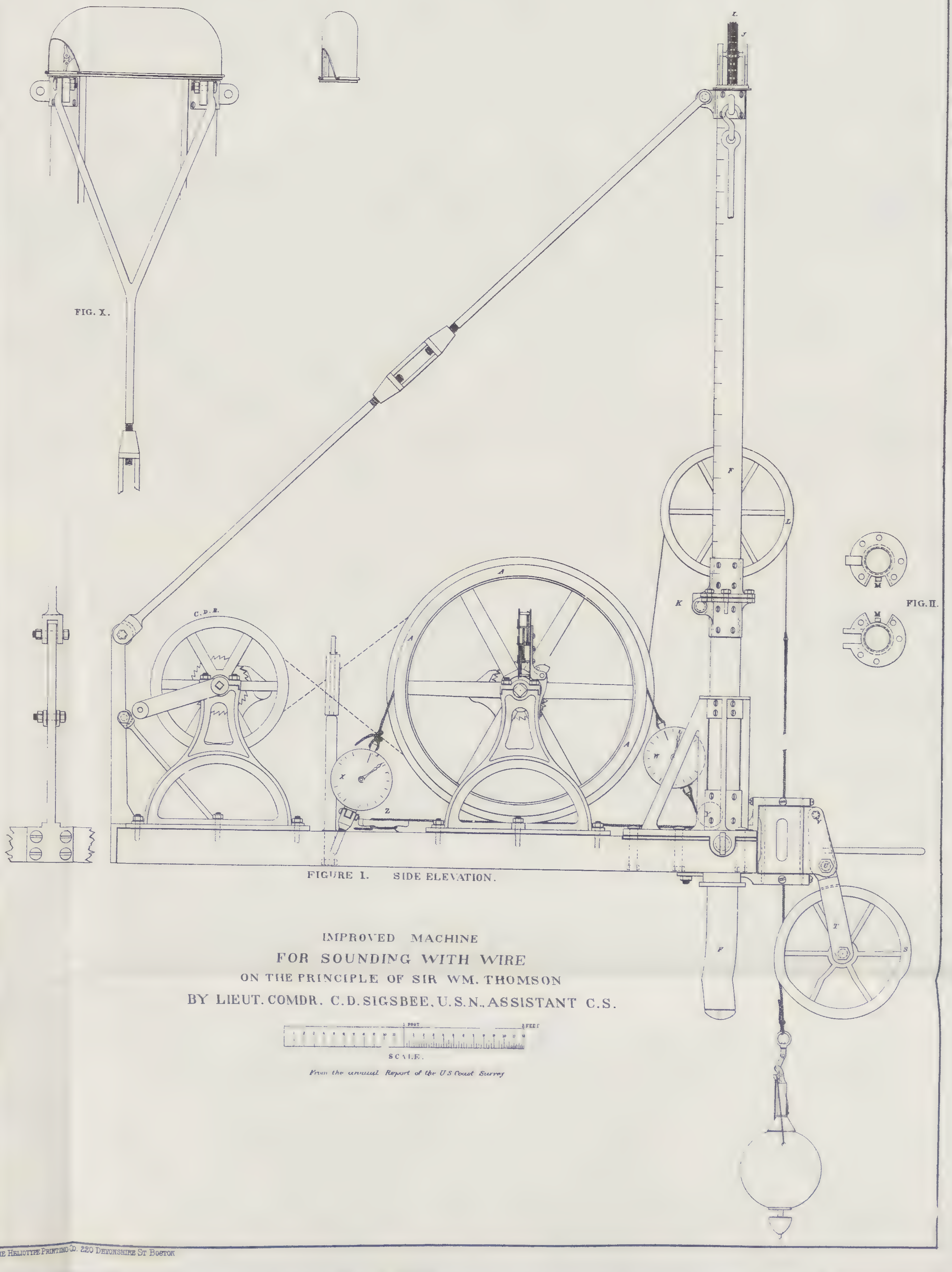


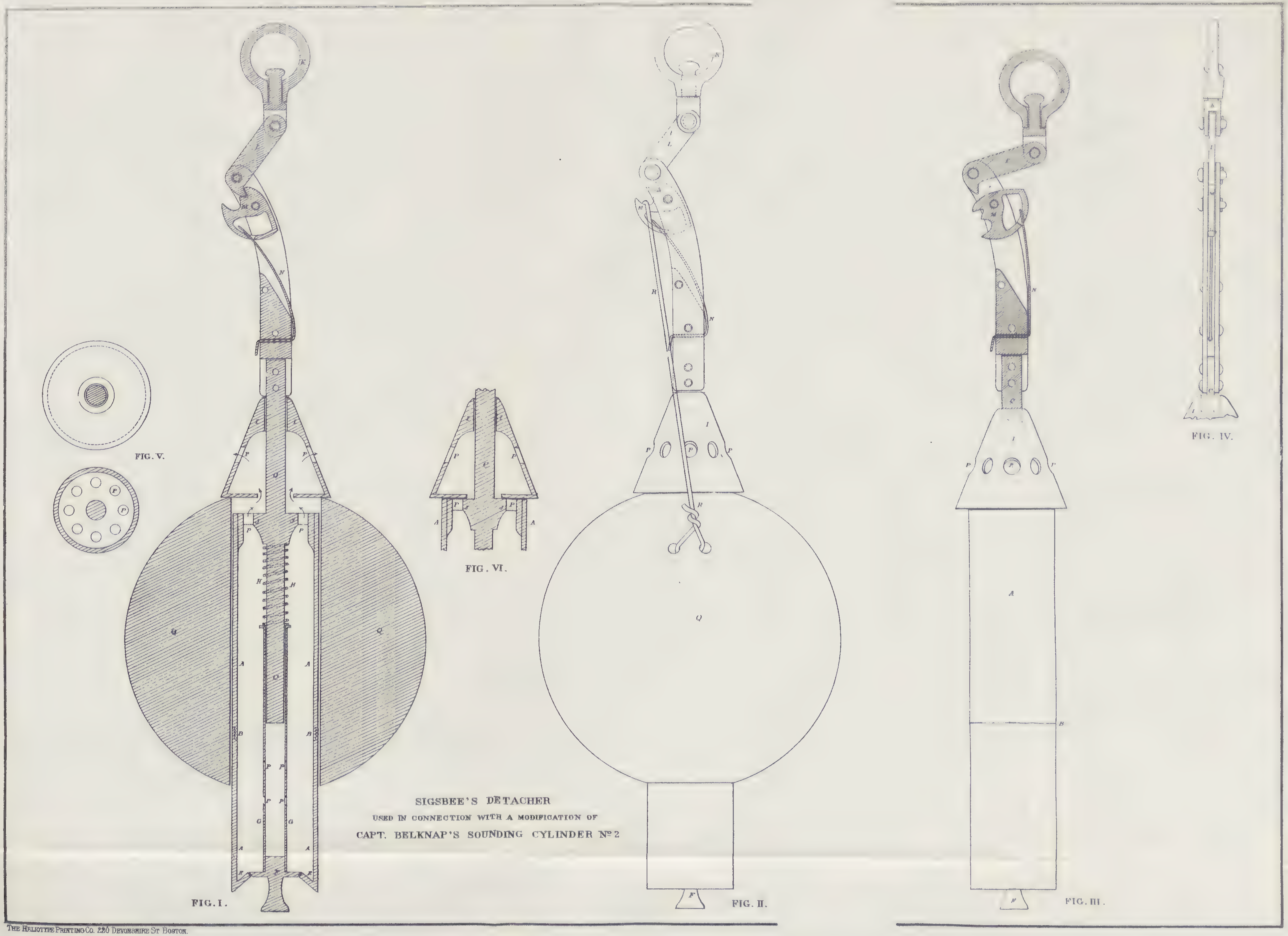
FIGURE I. SIDE ELEVATION.

IMPROVED MACHINE
FOR SOUNDING WITH WIRE
ON THE PRINCIPLE OF SIR WM. THOMSON
BY LIEUT. COMDR. C. D. SIGSBEE, U. S. N., ASSISTANT C. S.

SCALE.

From the annual Report of the U.S. Coast Survey

THE HELIOTYPE PRINTING CO. 220 DEVONSHIRE ST BOSTON



SIGSBEE'S DETACHER
USED IN CONNECTION WITH A MODIFICATION OF
CAPT. BELKNAP'S SOUNDING CYLINDER No 2

THE HELIOTYPE PRINTING CO. 220 DEVONSHIRE ST BOSTON.

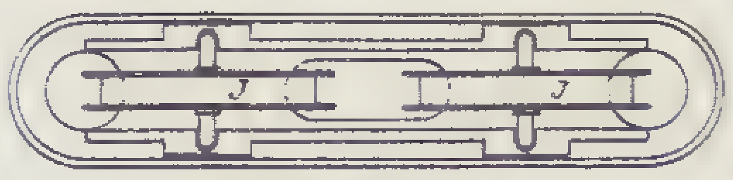


FIG. XII.

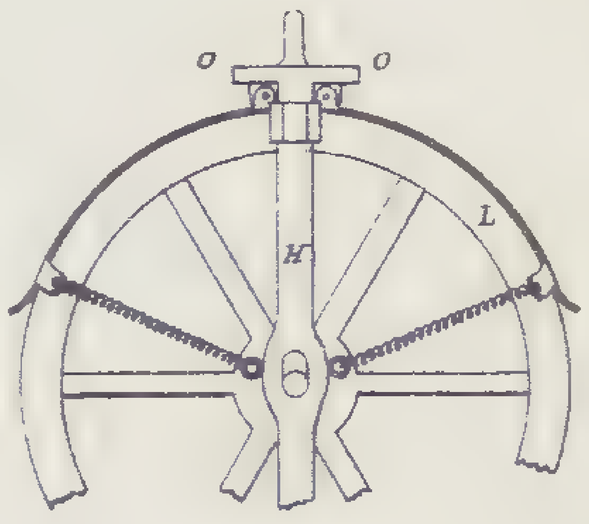


FIG. VII.

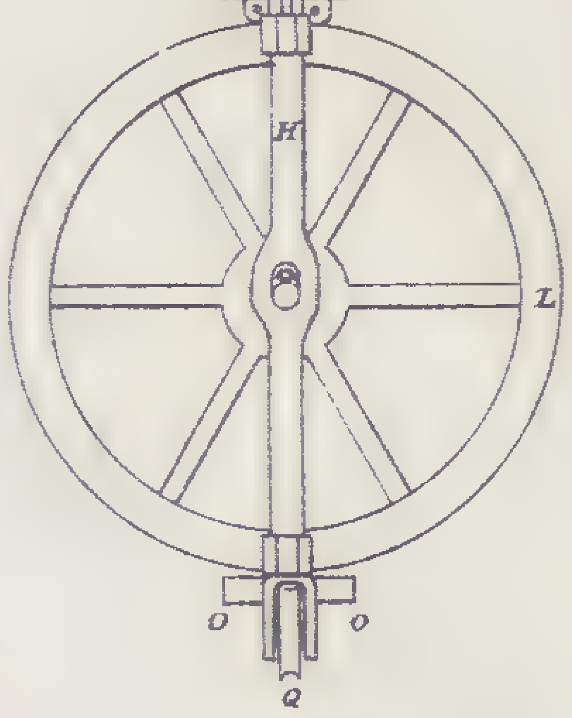


FIG. VIII.

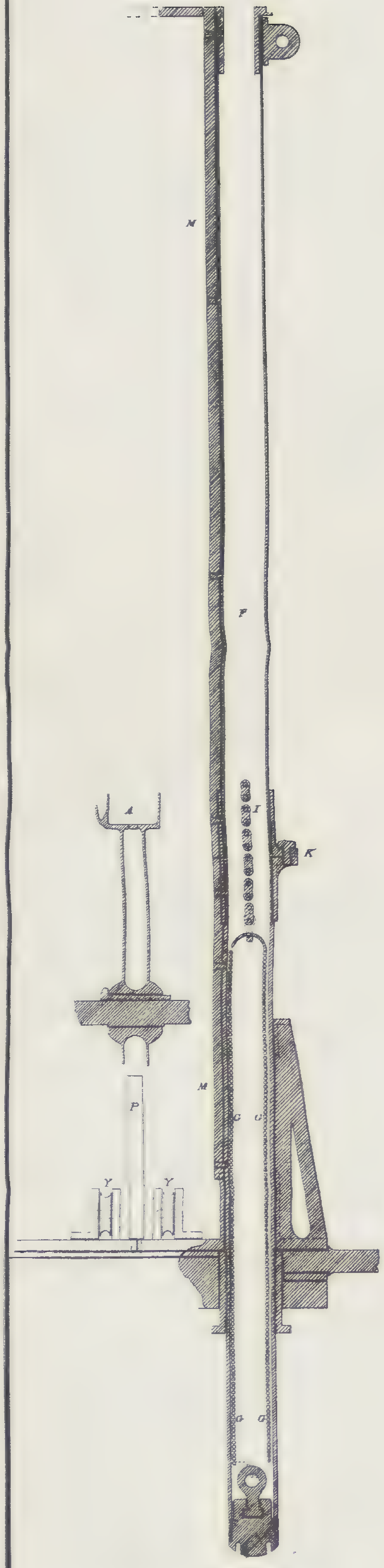


FIG. III.

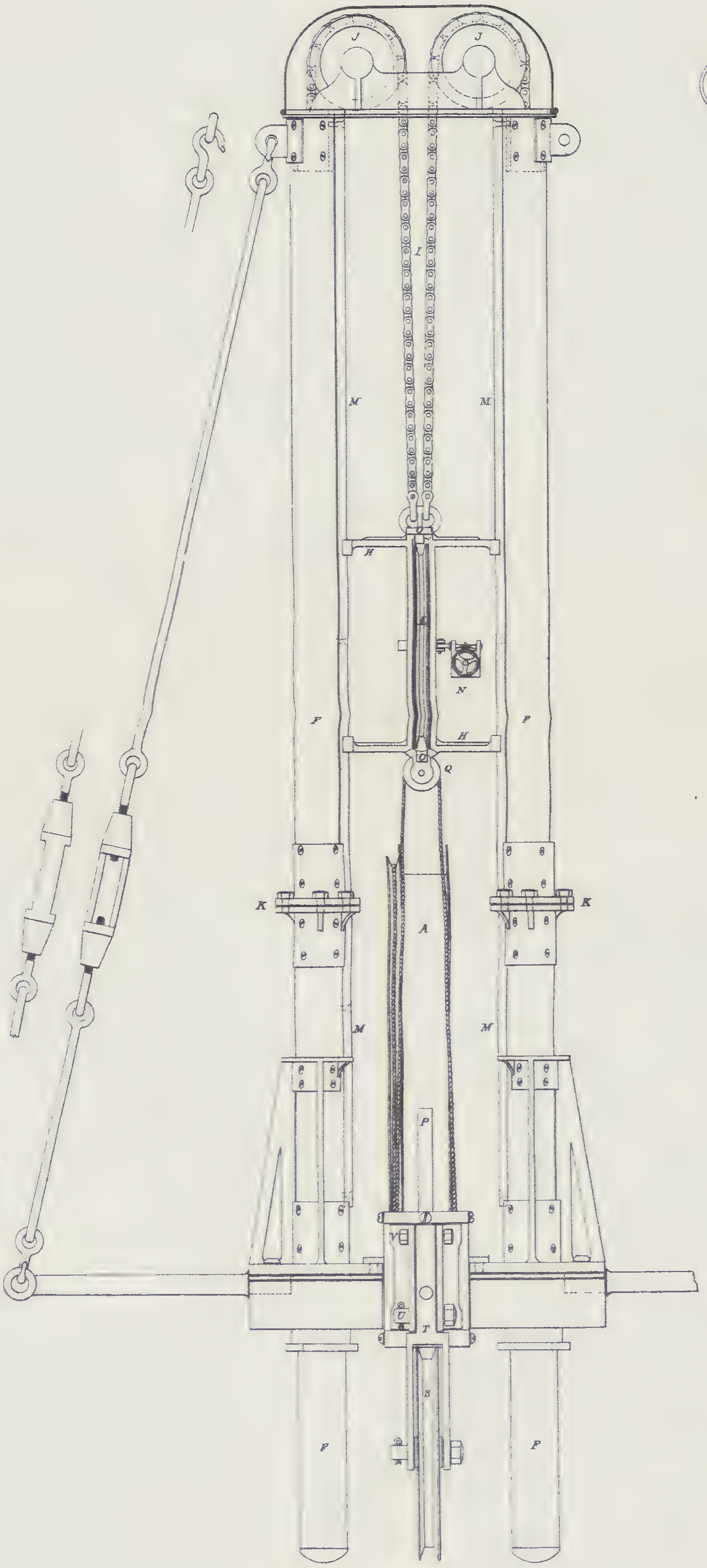


FIG. II.

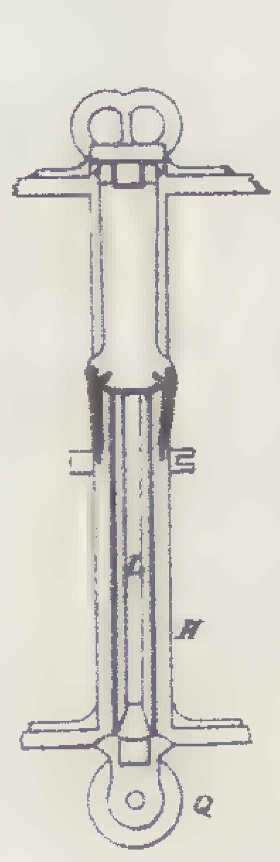


FIG. IX.

THE HELIOTYPE PRINTING CO. 220 DEVONSHIRE ST BOSTON

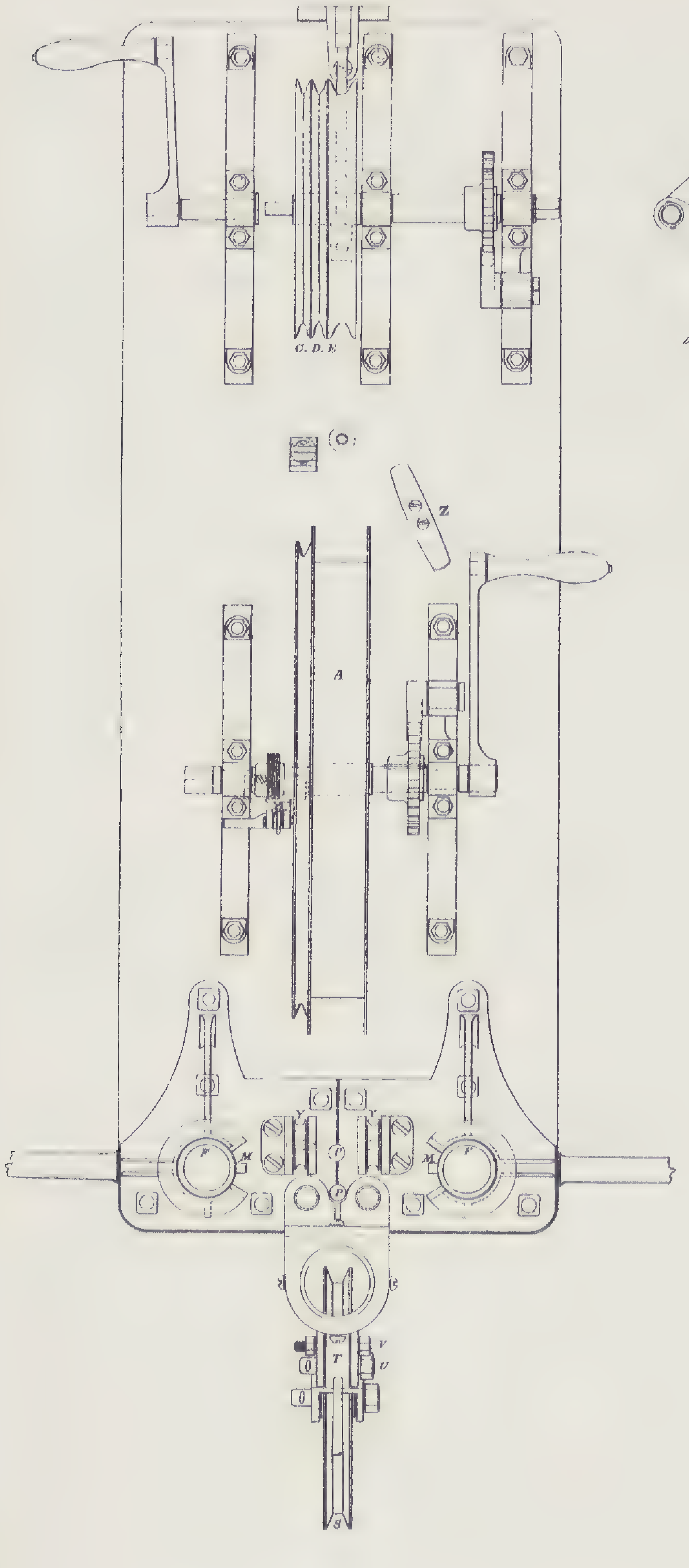


FIG. V.

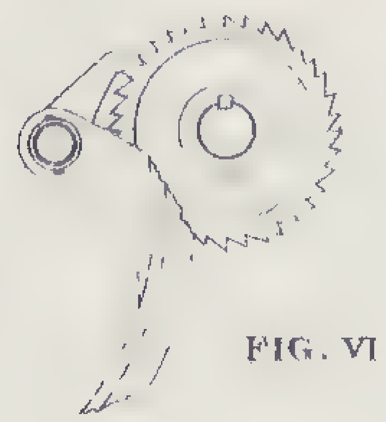


FIG. VI.

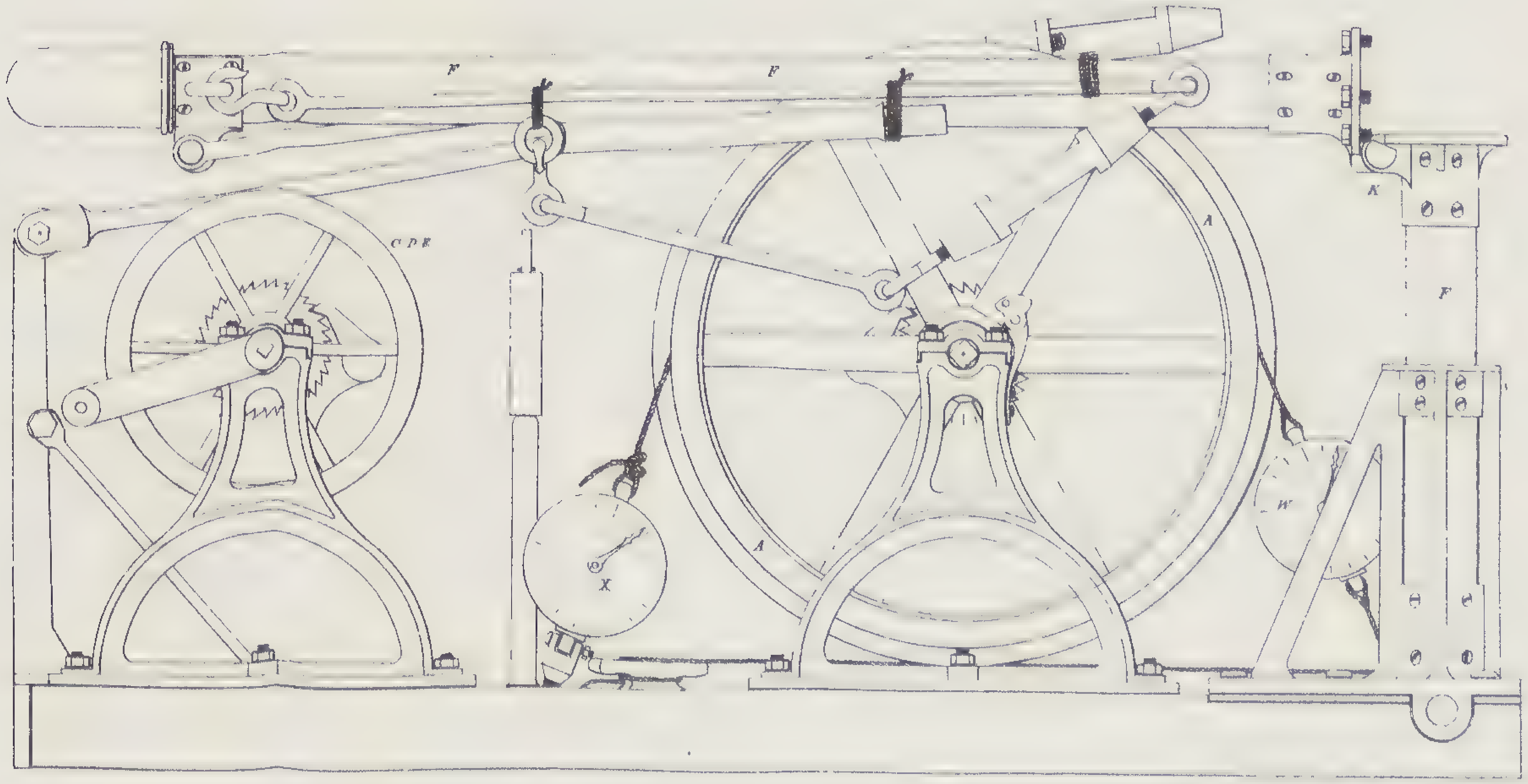
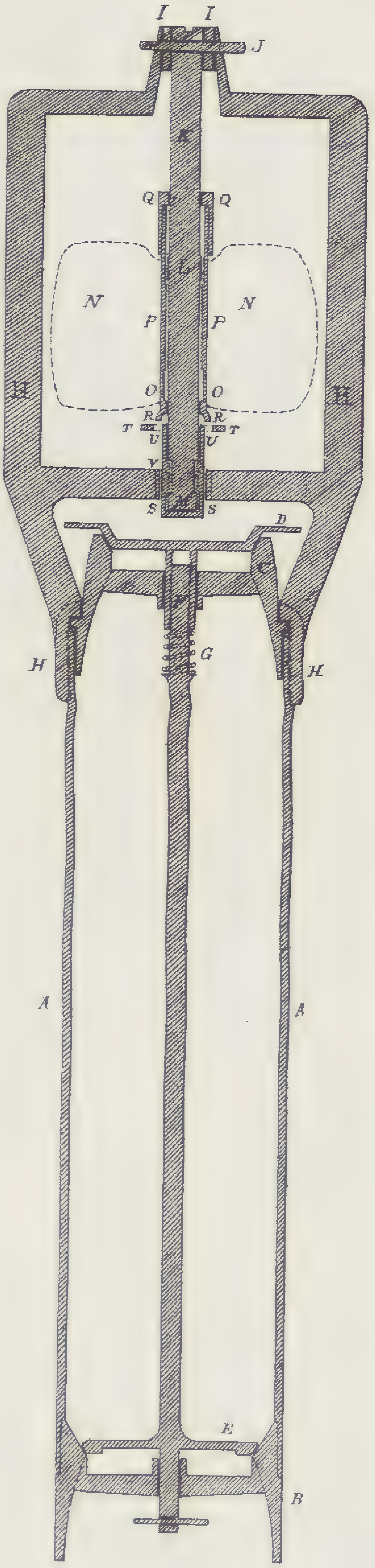


FIG. IV.



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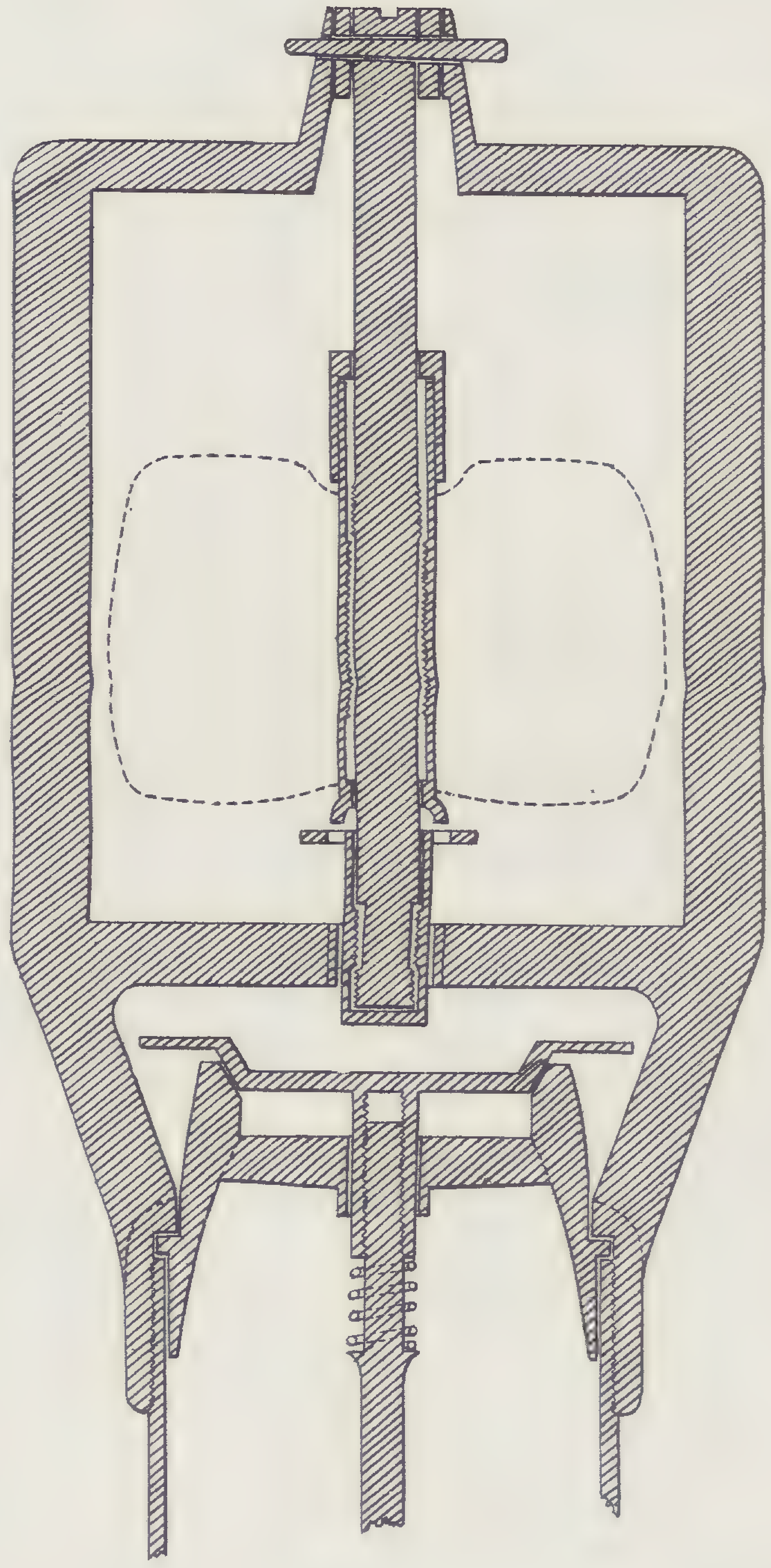

No. 9. — *Reports on the Results of Dredging, under the Supervision of* Alexander Agassiz, *in the Gulf of Mexico, by the United States Coast Survey Steamer "Blake,"* Lieutenant-Commander C. D. Sigsbee, U. S. N., Commanding.

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II.

Report on the Echini, by Alexander Agassiz, *Crinoids and Corals, by* L. F. de Pourtalès, *and Ophiurans, by* Theodore Lyman. *Preceded by a Bibliographical Notice of the Publications relating to the Deep-Sea Investigations carried on by the United States Coast Survey.*

INTRODUCTION.

Before giving the results of the renewed investigations into the character of the bottom of the sea in the vicinity of the coast of the United States, and of the Fauna living on it, instituted by the United States Coast Survey, it is instructive and interesting to give at this time a list, prepared by Mr. Pourtalès, of the publications relating to those researches made under the auspices of that great national work during the superintendence of A. D. Bache, B. Peirce, and C. P. Patterson. In the beginning the investigations were mainly restricted to microscopical examinations of the specimens of bottom brought up by the sounding lead, and the aim was originally to find therein aids to navigation. Later on the dredge was brought into requisition, and the greatly increased amount of material was worked up and published at the expense or under the direction of the Museum of Comparative Zoölogy.

1850. On the Distribution of Foraminifera on the Coast of New Jersey, as shown by the off-shore Soundings of the Coast Survey. By L. F. Pourtalès. Proc. Amer. Assoc. for Adv. of Sc., Charleston Meeting, 1850.

1850. On the Order of Succession of Parts in Foraminifera. By L. F. Pourtalès. Proc. Amer. Assoc. for Adv. of Sc., Charleston Meeting, 1850. Also Amer. Journ. of Sc. and Arts, 2d series, Vol. II. 1851.

1851. Extracts from the Report of Professor L. Agassiz to the Superintendent of the Coast Survey on the Examination of the Florida Reefs, Keys, and

Coast.* Coast Survey Report for 1851, and reprinted in Coast Survey Report for 1866.

1851. Microscopical Examination of Soundings made by the United States Coast Survey off the Atlantic Coast of the United States. By Professor J. W. Bailey. Smithsonian Contributions to Knowledge, Vol. II.

1853. Letter of the Superintendent to the Secretary of the Treasury reporting the Discovery by Lieutenants-Commanding Craven and Maffitt, of a Bank east of the Gulf Stream. Coast Survey Report for 1853. Also noticed in Proc. Amer. Assoc. for Adv. of Sc., Cleveland Meeting, 1853.

1853. Extract from Letters of L. F. Pourtalès, Assistant in the Coast Survey, to the Superintendent upon the Examination of Specimens of Bottom obtained in the Exploration of the Gulf Stream by Lieutenants-Commanding T. A. M. Craven and J. N. Maffitt, U. S. N. Coast Survey Report for 1853, and Proc. Amer. Assoc. for Adv. of Sc., Cleveland Meeting, 1853.

1854. Specimen Box for Deep-Sea Bottoms, by Lieutenant-Commanding T. A. Craven, U. S. N. Coast Survey Report for 1854.

1855. Instrument for procuring Specimens of Bottom in Sounding, by Lieutenant-Commanding B. F. Sands, U. S. N. Coast Survey Report for 1855.

1855. On the Characteristics of some Bottoms from the Cape Florida Gulf-Stream Section. By Professor J. W. Bailey. Coast Survey Report for 1855.

1856. On the origin of Greensand and its Formation in the Oceans of the present Epoch. By Professor J. W. Bailey. Proc. Boston Soc. Nat. Hist., 1856.

1858. Report of Assistant L. F. Pourtalès on the Progress made in the Microscopical Examination of Specimens of Bottom from Deep-Sea Soundings. Coast Survey Report for 1858.

1858. On the Genera Orbulina and Globigerina. By L. F. Pourtalès. Amer. Jour. of Sc. and Arts, 2d series, Vol. XXXVI. 1858.

1862. On the Origin, Growth, Substructure, and Chronology of the Florida Reef. By Captain E. B. Hunt, Corps of Engineers, U. S. A. Coast Survey Report for 1862.

1866. Report by Henry Mitchell, Assistant U. S. Coast Survey, upon Soundings across the Straits of Florida. Coast Survey Report for 1866.

1867. Report of Assistant H. Mitchell on Soundings made to develop the Character of the Straits of Florida between Key West and Havana. Coast Survey Report for 1867.

1867. Letters of Professor L. Agassiz on the Relations of Geological and Zoölogical Researches to General Interests in the Development of Coast Features. Coast Survey Report for 1867.

1867. Report on the Fauna of the Gulf Stream in the Straits of Florida. By L. F. Pourtalès. Coast Survey Report for 1867.

* Plates representing the principal reef corals of Florida, prepared to accompany the full Report, but never published, have recently been completed, and will be soon issued by the Museum of Comparative Zoölogy.

1867. Contributions to the Fauna of the Gulf Stream at great Depths. By L. F. de Pourtalès, Assistant U. S. Coast Survey. Bull. Mus. Comp. Zoöl., Vol. I. No. 6. Cambridge. 1867. pp. 18.

1868. Contributions to the Fauna of the Gulf Stream at great Depths (2d series). By L. F. de Pourtalès, Assistant U. S. Coast Survey. Bull. Mus. Comp. Zoöl., Vol. I. No. 7. Cambridge. 1868. pp. 22.

1868. Report of Assistant L. F. Pourtalès on Dredgings made in the Sea near the Florida Reef. Coast Survey Report for 1868.

1869. Report upon Deep-Sea Dredgings in the Gulf Stream during the Third Cruise of the U. S. Steamer Bibb, addressed to Professor B. Peirce, Superintendent U. S. Coast Survey. By L. Agassiz. Bull. Mus. Comp. Zoöl, Vol. I. No. 13. Cambridge. 1869. pp. 24. Also Coast Survey Report for 1869.

1869. The Gulf Stream. Characteristics of the Atlantic Sea-Bottom off the Coast of the United States. By L. F. Pourtalès. Coast Survey Report for 1869.

1869. Preliminary Report on the Echini and Starfishes dredged in Deep Water between Cuba and the Florida Reef. By L. F. de Pourtalès, Assistant U. S. Coast Survey. Prepared by Alexander Agassiz. Bull. Mus. Comp. Zoöl., Vol. I. No. 9. Cambridge. 1869. pp. 56.

1869. Preliminary Report on the Ophiuridæ and Astrophytidæ dredged in Deep Water between Cuba and the Florida Reef. By L. F. de Pourtalès, Assistant U. S. Coast Survey. Prepared by Theodore Lyman. Bull. Mus. Comp. Zoöl., Vol. I. No. 10. Cambridge. 1869. pp. 46.

1869. List of the Crinoids obtained on the Coasts of Florida and Cuba by the U. S. Coast Survey Gulf Stream Expeditions in 1867, 1868, and 1869. By L. F. de Pourtalès, Assistant U. S. Coast Survey. Bull. Mus. Comp. Zoöl., Vol. I. No. 11. Cambridge. 1869. pp. 4.

1869. List of Holothuridæ from the Deep-Sea Dredgings of the United States Coast Survey. By L. F. de Pourtalès, Assistant U. S. Coast Survey. Bull. Mus. Comp. Zoöl., Vol. I. No. 12. Cambridge. 1869. pp. 3.

1870. Preliminary Report on the Crustacea dredged in the Gulf Stream in the Straits of Florida, by L. F. de Pourtalès, Assistant U. S. Coast Survey. Part I. Brachiura. Prepared by Dr. William Stimpson. Bull. Mus. Comp. Zoöl., Vol. II. No. 2. Cambridge. 1870. pp. 52.

1870. Der Boden des Golfstromes und dez Atlantischen Küste Nord Amerika's. Von L. F. v. Pourtalès. Petermann's Geograph. Mittheilungen, 1870. Heft XI. pp. 5. 1 map.

1870. Grundzüge einer Spongien Fauna des Atlantischen Gebietes. Von Oscar Schmidt. Leipzig. 1870. Fol. pp. 88. Pls. 6.

1871. Appendix to the Preliminary Report (Bull. No. 9, Vol. I.) on the Echini collected by L. F. de Pourtalès. By Alexander Agassiz. Bull. Mus. Comp. Zoöl., Vol. II. No. 5. Cambridge. 1871. pp. 3.

1871. Report on the Brachiopoda obtained by the U. S. Coast Survey Expedition in charge of L. F. de Pourtalès, with a revision of the Craniidæ and

Discinidæ. By W. H. Dall. Bull. Mus. Comp. Zoöl., Vol. III. No. 1. Cambridge. 1871. pp. 45. Pls. 2.

1871. Deep-Sea Corals. By L. F. de Pourtalès, Assistant U. S. Coast Survey. Illustrated Catalogue of the Mus. Comp. Zoöl., Vol. II. No. 4. (Memoirs, Vol. II. No. 4.) Cambridge. 1871. pp. 93. Pls. 8.

1871. Supplement to the Ophiuridæ and Astrophytidæ. By Theodore Lyman. Illustrated Catalogue of the Mus. Comp. Zoöl., Vol. II. No. 6. (Memoirs, Vol. II. No. 6.) Cambridge. 1871. pp. 14. Pls. 2.

1871. Contributions from the Laboratory of the Lawrence Scientific School, No. 13. On some Rocks and other Dredgings from the Gulf Stream. By S. P. Sharples. Amer. Jour. of Sc. and Arts. February, 1871. pp. 4.

1871. A Letter concerning Deep-Sea Dredging, addressed to Professor Benjamin Peirce. By Louis Agassiz. Bull. Mus. Comp. Zoöl., Vol. III. No. 3. Cambridge. 1871. pp. 5.

1872. Echini of the Eastern Coast of the United States, together with a Report on the Deep-Sea Echini collected in the Straits of Florida by L. F. de Pourtalès, Assistant U. S. Coast Survey, in the Years 1867 – 69. By Alexander Agassiz. (Being Part II. of the Revision of the Echini.) Illustrated Catalogue of the Mus. Comp. Zoöl., No. VII. (Memoirs of the Mus. Comp. Zoöl, Vol. III.) Cambridge. 1872 – 74. pp. 132. Pls. 42.

1872. Floridan Bryozoa, collected by Count L. F. de Pourtalès, described by F. A. Smitt. Part I. Kongl. Svenska Vetenskaps Akad. Handlinger. Bandet 10, No. 11. Stockholm. 1872. pp. 20 Pls. 5.

Do. Part II. (*Ibid.*, Bandet 11, No. 4.) Stockholm. 1873. pp. 83. Pls. 13.

1873. Interim Report on the Hydroids collected by L. F. de Pourtalès during the Gulf Stream Exploration of the U. S. Coast Survey. By George J. Allman. Bull. Mus. Comp. Zoöl., Vol. III. No. 7. Cambridge. 1873. pp. 2.

1873. The Echini collected on the Hassler Expedition. By Alexander Agassiz. Bull. Mus. Comp. Zool., Vol. III. No. 8. Cambridge. 1873. pp. 4.

1874. The Zoölogical Results of the Hassler Expedition. I. Echini, Crinoids, and Corals. By Alexander Agassiz and L. F. de Pourtalès. pp. 54. 15 woodcuts. Pls. 10. II. Ophiuridæ and Astrophytidæ, including those dredged by the late Dr. Stimpson. By Theodore Lyman. Illust. Cat. Mus. Comp. Zoöl., No. 8. (Memoirs, Vol. IV.) Cambridge. 1874. pp. 34. 4 woodcuts. Pls. 5.

1875. Corals at the Galapagos Islands. By L. F. de Pourtalès. Amer. Journ. of Sc. and Arts, 3d series, Vol. 10. 1875.

1875. Mission scientifique au Mexique et dans l'Amérique centrale. Recherches zoologiques 5ᵉ Partie. Études sur les Xiphosures et Crustacés podophthalmaires par M. Alphonse Milne Edwards. Paris. 1875. (Not completed, contains description of part of the Crustacea of the Gulf Stream Explorations and Hassler Expedition.)

1875. Révision des Stellérides par Edmond Perrier. Annales de Zoologie et de Physiologie experimentale. T. IV. Paris. 1875. (Same remark as preceding.)

1876. Die Schlangen und Eidechsen der Galapagos Inseln von Dr. F. Steindachner. Festschrift der K. K. Zool. Bot. Gesell. in Wien. 1876. pp. 29. Pls. 7. (Based in part on specimens collected in the Hassler Expedition.)

Dr. Steindachner has described fishes collected in the Hassler Expedition, in "Sitzungsber, der K. K. Akad. der Wissensch. in Wien," passim.

1876. E. v. d. Broeck, Étude sur les Foraminifères de la Barbade, recueillis par L. Agassiz, précédée de quelques considérations sur la classification et la nomenclature des Foraminifères. Ann. Soc. Belg. Micr. II.

1877. Report on the Hydroida collected during the exploration of the Gulf Stream by L. F. de Pourtalès, Assist. U. S. Coast Survey. By George J. Allman. Mem. of the Mus. Comp. Zoöl., Vol. V. No. 2. Cambridge. 1877. pp. 66. Pls. 34.

In Preparation.

The Annelids of the Straits of Florida. By Prof. Ehlers.

For the distribution of the collections of the Blake Expedition, yet to be worked up, see Bull. Mus. Comp. Zoöl., Vol. V. No. 6, p. 62.

ECHINI.

Cidaris tribuloides Bl.

Station No. 10.	Lat. 24° 44′ N., Long. 83° 26′ W.	37 fms.
" " 11.	Lat. 24° 43′ N., Long. 83° 25′ W.	37 fms.

Dorocidaris papillata A. Ag.

Station No. 26.	Lat. 24° 37½′ N., Long. 83° 36 W.	110 fms.
" " 32.	Lat. 23° 52′ N., Long. 88° 5′ W.	95 fms.
" " 9.	7 miles S. by W. from Sand Key.	111 fms.
" " 45.	Lat. 25° 33′ N., Long. 84° 21′ W.	101 fms.
* (Sigsbee.)	Lat. 26° 31′ N., Long. 85° 53′ W.	119 fms.
Station No. 21.	Lat. 23° 2′ N., Long. 83° 13′ W.	287 fms.
" " 5.	Lat. 24° 15′ N., Long. 82° 13′ W.	229 fms.
" " 2.	4 miles from Morro Light.	805 fms.

Dorocidaris Blakei A. Ag. spec. nov.

Plate IV.

This species is one of the most interesting Echini dredged up by the "Blake." The recent *Cidaridæ* thus far known do not by any means show the great variety in the form of the radioles which we find so common among the fossil genera of the family. The present species, however, shows, far better than any of our recent *Goniocidaridæ*, how dangerous it is to describe new species merely

* All the stations having "(Sigsbee)" are dredgings made by Captain Sigsbee after I left the "Blake" for the season.

from the shape of the spines. For, certainly, if the present species had been dredged without its two or three huge fan-shaped spines, it would have been placed in the genus *Dorocidaris,* and have been undoubtedly referred to *papillata* or to its Florida variety, *D. abyssicola,* while the isolated fan-shaped spines so nearly identical in shape to those of the Jurassic *Rhabdocidaris* (*Phyllacanthus* Br.) *remus* Des. would unhesitatingly have been referred to that genus. This merely shows how little we are as yet able to determine, among the *Cidaridæ,* the value of either generic or specific characters, and we must possess far more material from among the fossil species, especially in the way of spines associated with their tests, before we can make the much needed accurate revision of the group of *Cidaridæ.* In the few specimens dredged by Captain Sigsbee there are none of the spines showing a passage from those considered thus far as characteristic of *Dorocidaris,* and the peculiar fan-shaped spines, of which there are from two to three on each specimen.

The scrobicular ring is edged by a row of larger secondary tubercles, the ambulacral area is flexuous, the poriferous zone nearly as broad as the median ambulacral area, the primary tubercles are not crenulate, mammary boss large; the scrobicular areas well separated by the secondary and miliary tubercles, not confluent even towards actinal extremity. In the specimen figured [natural size in Plate IV.] there are six primary tubercles in the interambulacral area. The actinal area is smaller than the abactinal system. The ornamentation of the fan-shaped spines is similar to that of the cylindrical spines, the rows of spinules becoming gradually changed into serrations spreading more and more and becoming somewhat less prominent towards the extremity, rows of smaller serrations being intercolated as the radioles spread.

The broad end of the fan-shaped radioles is sometimes slightly concave. When alive, these Echini were of a brilliant vermilion color.

(Sigsbee.) Off Havana. Lat. 22° 11′ N., Long. 82° 21′ W. 243 – 450 fms.
" Lat 22° 09′ N., Long. 82° 23′ W. 158 fms.
" Off Havana. 242 fms.
" Off Havana. 175 fms.
" Off Havana. Lat. 22° 09′ N., Long. 82° 21′ W. 242 fms.

A spine closely allied to those of *Goniocidaris bispinosa* was brought up from 242 fathoms, in Lat. 22° 09′ 30″ N., Long. 82° 11′ 30″ W. Unfortunately no test of *Cidaris* came up in the haul. This spine is different from those of any of the specimens of *Cidaris* thus far dredged either by Mr. Pourtalès or myself.

Salenia varispina A. Ag.

I still retain this species in the genus *Salenia,* notwithstanding Dr. Duncan has proposed to remove it to *Peltastes.* As I have already stated in the Revision of the Echini, and in the Bull. M. C. Z. when first describing this species, it differs somewhat from *Salenia* proper, but certainly it does not belong to the group of *Salenidæ* to which *Peltastes* is associated, in which the subanal plate is placed directly opposite one of the genital plates, while in all the recent *Sale-*

nidæ thus far described * they at least all agree in having an ocular plate opposed to the median line of the subanal plate, the adjoining genital plates uniting just in front of this imaginary median line to separate the ocular plate more or less from the anal system.

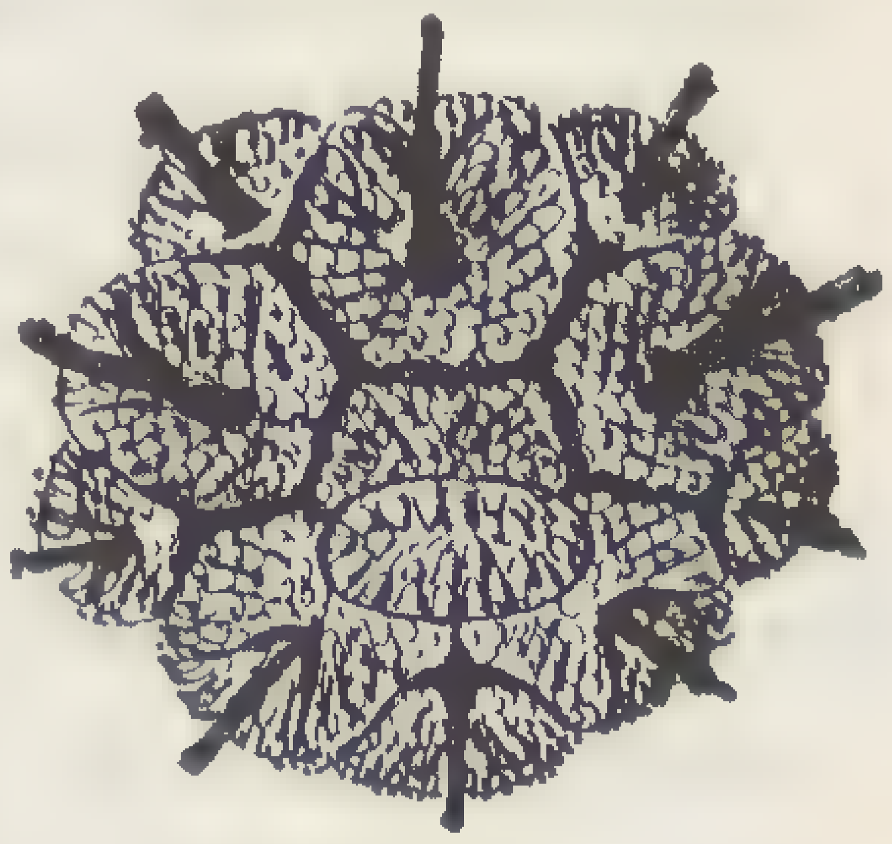
Station No. 29. Lat. 24° 36′ N., Long. 84° 5′ W. 955 fms.

Salenia Pattersoni A. Ag. spec. nov.

Plate V.

This is the most exquisitely colored of the living *Salenidæ* thus far found. When alive the test is of a light cream-color, as well as the shafts of the primary spines. These are banded with brilliant vermilion, the cream-color and vermilion nearly equally divided. This coloring, at first glance, gives to this species very much the appearance of the Florida species of *Cœlopleurus.* The secondary spines are also cream-colored, but separated at the base by dark violet lines, extending from the apical system in the median ambulacral and interambulacral line to the actinal system. Similar dark violet lines separate the genital plates and the superanal plate from one another, the dark lines of the median interambulacra and ambulacra extending some distance into its corresponding genital and ocular plates (Pl. V. and Fig. 1). The primary spines are from three to four times the diameter of the test, with minute, sharp, irregular serrations. These are frequently worn, and the radiole presents a nearly smooth surface, slightly granular. The primary spines of this species are remarkably uniform in their appearance, differing merely in length, as mentioned above, but we find nothing of the great variation in the spines characteristic of *S. varispina.* The papillæ or secondary spines are long, with rounded ends slightly concave at extremity. The outer edge of the abactinal system and the median line of the ambulacral area are thickly studded with minute globular pedicellariæ. The plates of the abactinal system are covered by a coarse granulation, which, towards the outer edge of the genital plates, becomes minute sessile spines. The sutures between the genital plates are deep, as well as the lines separating them from the abactinal part of the ocular plates. The anal system carries short, stout, pointed spines. None of the genital pores are very distinct, with the exception of the one carrying the madreporic body, which consists of a few minute holes adjoining the large genital pore. The ocular plate opposite the superanal plate nearly touches the anal system, far nearer than in *S. varispina.*

Fig. 1.



In a specimen of the one of the size figured in Plate V., there are five primary tubercles in the interambulacral area. The secondary tubercles, carry-

* Vide A. Agassiz, Rev. Echini; Loven, S. Echinoidées; Duncan, M. P. Ann. and Mag. 1878; Wyv. Thomson, Voyage of the Challenger.

ing the flat papillæ, are arranged vertically in open arcs round them ; and these arcs, running together along the median interambulacral line, form two wavy vertical rows of tubercles, closely packed, which gives to the median interambulacral area a somewhat sunken aspect, as in *Goniocidaris*. The ambulacral tubercles, as in *Salenia varispina*, resemble in their arrangement those of *Hemicidaris*, forming two vertical rows, being larger near ambitus and gradually diminishing rapidly towards actinostome and gradually towards apical system. The largest ambulacral tubercles are not larger than the secondary, surrounding the primaries in the interambulacral area. Ambulacral zone narrow, pores arranged in a slightly undulating line, irregularly following the outline of the primary plates in the interambulacral area.

Off Havana. Lat. 22° 09′ N., Long. 82° 21′ 30″ W. 175 fms. ; 242 fms. (Sigsbee.)

Arbacia punctulata Gray.

Station No. 36. Lat. 23° 13′ N., Long. 89° 10′ W. 84 fms.
" " 39. 16 miles north of Zoblos Islands. 14 fms.

Cœlopleurus floridanus A. Ag.

Station No. 32. Lat. 23° 52′ N., Long. 88° 05′ W. 95 fms.
" " 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.
" " 23. Lat. 23° 01′ N., Long. 83° 14′ W. 190 fms.
" " 21. Lat. 23° 02′ N., Long. 83° 13′ W. 287 fms.
" " 2. 4 miles from Morro Light. 805 fms.
" " 40. Lat. 23° 26′ N., Long. 84° 02′ W. 1323 fms.
(Sigsbee.) Off Havana. Lat. 22° 09′ 15″ N., Long. 82° 21′ W. 177 fms.
" Off Havana. Lat. 22° 09′ 30″ N., Long. 82° 11′ 30″ W. 242 fms.

Diadema setosum Gray.

Littoral Bahia Honda, Marianao.

Aspidodiadema microtuberculatum A. Ag. gen. et spec. nov.

A number of young specimens of *Aspidodiadema microtuberculatum* A. Ag. [The adult of this will be figured in Challenger Echini, Plate VIII. Figs. 10–16.] There was no series of young specimens among the Challenger Echini. The small plates on the anal system, as characteristic of this species, are found on the smallest specimens collected by the "Blake."

Station No. 41. Lat. 23° 42′ N., Long. 83° 13′ W. 860 fms.
" " 29. Lat. 24° 36′ N., Long. 84° 05′ W. 955 fms.
" " 33. Lat. 24° 1½′ N., Long. 88° 58′ W. 1568 fms.

Echinometra subangularis Desml.

Littoral Bahia Honda, Havana.
Yucatan Bank, in all dredgings less than 14 fathoms.

Temnechinus maculatus A. Ag.

Station No. 26 Lat. 24° 37½′ N., Long. 83° 36′ W. 110 fms.
" " 11. Lat. 24° 43′ N., Long. 83° 25′ W. 37 fms.
" " 32. Lat. 23° 52′ N., Long. 88° 05′ W. 95 fms.
" " 36. Lat. 23° 13′ N., Long. 89° 10′ W. 84 fms.
" " 6. Lat. 24° 17½′ N., Long. 82° 09′ W. 137 fms.
" " 5. Lat. 24° 15′ N., Long. 82° 13′ W. 229 fms.
(Sigsbee.) Florida Bank. Lat. 26° 31′ N., Long. 85° 53′ W. 119 fms.

Trigonocidaris albida A. Ag.

Station No. 5. Lat. 24° 15′ N., Long. 82° 13′ W. 229 fms.
(Sigsbee.) Off Havana. Lat. 22° 11′ N., Long. 82° 21′ W. 243–450 fms.
" Off Havana. Lat. 22° 09′ N., Long. 82° 23′ W. 175 fms.
" Off Havana. Lat. 22° 09′ N., Long. 82° 21′ 30″ W. 242 fms.
" Off Havana. 158 fms.

Echinus gracilis A. Ag.

(Sigsbee.) Off Havana. Lat. 22° 09′ N., Long. 82° 23′ W. 175 fms.

Toxopneustes variegatus A. Ag.

Station No. 11. Lat. 24° 43′ N., Long. 83° 25′ W. 37 fms.
" " 39. 16 miles north of Zoblos Islands. 14 fms.
" " 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.

Hipponoë esculenta A. Ag.

Littoral Bahia Honda, Yucatan Bank, every cast within 14 fathoms.
Station No. 39. 16 miles north of Zoblos Islands. 14 fms.

Echinocyamus pusillus Gray.

Station No. 26. Lat. 24° 37½′ N., Long. 83° 36′ W. 110 fms.
" " 5. Lat. 24° 15′ N., Long. 82° 13′ W. 229 fms.
" " 2. 4 miles from Morro Light. 805 fms.
" " 20. Lat. 23° 02.5′ N., Long. 83° 11′ W. 220 fms.
(Sigsbee.) Off Havana. 480 fms.
" Off Havana. Lat. 22° 11′ N., Long. 82° 21′ W. 243–450 fms.
" Off Havana. Lat. 22° 09′ N., Long. 82° 01′ W. 242 fms.
" Florida Bank. Lat. 26° 31′ N., Long. 85° 03′ W. 119 fms.

Clypeaster subdepressus Agass.

Station No. 36. Lat. 23° 13′ N., Long. 89° 10′ W. 84 fms.

Echinanthus rosaceus Gray.

Station No. 39. 16 miles north of Zoblos Islands. 14 fms.

Encope Michelini Agass.

Station No. 39. 16 miles north of Zoblos Islands. 14 fms.

Echinoneus semilunaris Lamk.

Marianao, Havana, thrown upon beaches.
(Sigsbee.) Off Havana. 80 fms.

Echinolampas depressa Gray.

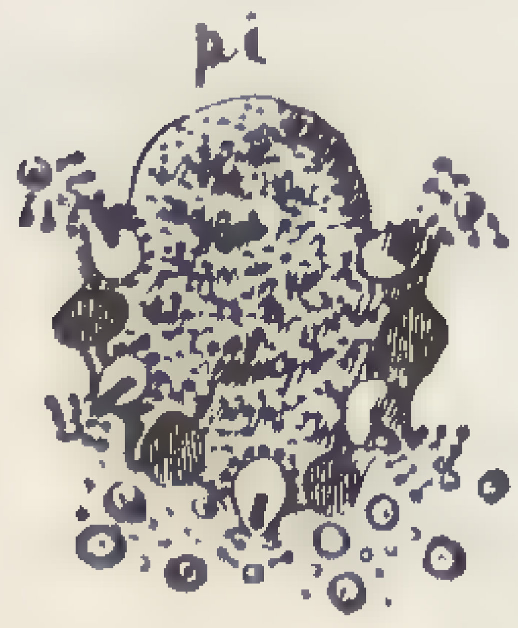
Station No. 32. Lat. 23° 52′ N., Long. 88° 05′ W. 95 fms.
" " 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.

Conoclypus Sigsbei A. Ag. spec. nov.

Plates I., II.

This magnificent species is by far the most striking sea-urchin I have seen. I shall always remember the particular haul when, on the edge of the Yukatan Bank, the dredge came up containing half a dozen of these huge brilliant lemon-colored Echini. The test is covered by small primary tubercles of uniform size, quite regularly arranged on the plates of the test, both on the ambulacral and interambulacral area. The tubercles on the actinal side are similarly arranged, with the exception of the vicinity of the ambitus, where they are more closely crowded together. The primary tubercles are surrounded by a deeply sunken narrow scrobicular area, much as in *Echinolampas* and *Rhynchopygus.* The miliary tubercles are uniformly scattered between the primaries, and are separated by irregular transparent glassy ridges and elongated pits, much as we find them on the actinal side of *Rhynchopygus*, but near the ambitus on the actinal side, where the primary tubercles are more closely crowded, they are separated by closely packed secondary tubercles. The actinal bourrelets are very prominent ; the floscelle large, broad, well defined, extending nearly one third the distance of the actinostome to the ambitus. There are small, elongate, short-stemmed, slender, pyramidal pedicellariæ scattered irregularly over the actinal surface, much less numerous on the side of the test. The primary spines are short, slender, cylindrical, rapidly tapering at extremity. The miliary and secondary spines similar to primary, only smaller. The apical system compact (Fig. 2) ; all the genital plates coalesce, centre of apex occupied by the madreporic, developed into a prominent knob, *pi*, on the sides of which the ocular plates rise ; four large genital openings, odd posterior genital wanting ; the ambulacral zones all identical in structure. Two rows, made up of distant pores, extending two thirds the distance of the apex to ambitus, form rudimentary petaloid ambulacra. The pores suddenly come close together, the poriferous zones becoming extremely narrow, and extending thus over to the actinal side until they meet the floscelles. Anal system occupied by an outer row of three large plates and one smaller one, with a few smaller plates closing the outer edge of the anal system. While describ-

Fig. 2.



ing the young Echini dredged by Mr. Pourtalès in 1867–68, I figured as the young of *Echinolampas depressa* a number of small Echini, which I am now convinced are the young of *Conoclypus* and not of *Echinolampas*. After my departure Captain Sigsbee dredged off Havana a few young as well as small specimens identical with those dredged by Mr. Pourtalès. These young specimens had the same yellow color of the old *Conoclypus*, as well as all the characters of the adult, with the exception of the position of the anus, which was placed above the ambitus in the smallest specimen (as is the case in the majority of young *Spatangoids* and *Clypeastroids*). Some of the young figured by me in Pl. XVI., Rev. Echini, are the young of *Echinolampas*, while others are the young of *Conoclypus*. Figs. 17, 18, 19, 21, Pl. XVI., belong to *Echinolampas*, as well as Figs. 6, 7, while Figs. 1, 2, 3, 8, 9, 10, belong to *Conoclypus*, — the young of *Echinolampas*, for which the petaloid ambulacra (6, 7) were drawn, being somewhat more elongate and showing at an early age the rudiments of a petaloid structure, while in *Conoclypus* the petaloid structure, though present, is far less developed than in *Echinolampas*, being merely a widening formed by the double pores of that of the ambulacral area.

Station No. 32. Lat. 23° 52′ N., Long. 88° 05′ W. 95 fms.
(Sigsbee.) Off Havana. Lat. 22° 11′ N., Long. 82° 21′ W. 242–450 fms.
" Off Havana. 175 fms.

Neolampas rostellata A. Ag.

Station No. 5. Lat. 24° 15′ N., Long. 82° 13′ W. 229 fms.

Homolampas fragilis A. Ag.

Fragments of a large specimen of *Homolampas*, very probably the adult of *H. fragilis* A. Ag., of which young specimens were dredged by Mr. Pourtalès [A. Ag., Rev. Echini, Pl. XVII. Figs. 13–21]. These fragments show that *H. fragilis* is closely allied to a large species of *Homolampas* [*H. fulva* A. Ag.], to be described and figured in Pl. XXIV. of the memoir on the Echini of the Challenger Expedition. It differs first in the closer tuberculation of the miliaries, the larger number of primary tubercles in the interambulacral areas near the abactinal system, and the coarser tuberculation of the odd anterior groove above the ambitus; also in the larger number of primary plates. No part of the anal system or of the actinal system was found among the fragments.

Station No. 31, Lat. 24° 33′ N., Long. 84° 23′ W., 1920 fathoms.

Pourtalesia miranda A. Ag.

(Sigsbee.) Off Havana. 242 fms. Fragments.

Eupatagus longispinus A. Ag. spec. nov.

Fragments of a *Spatangoid* allied to *Eupatagus*, *Macropneustes*, *Platybrissus*, and *Paleopneustes*, unfortunately too imperfect for generic determination. The petals are flush with test, closed somewhat, as in *Eupatagus* and *Platybrissus*.

There is, however, in the fragment of the anal part of test a very distinct and well-defined subanal fasciole, as in *Eupatagus*, and a somewhat indistinct peripetalous fasciole close to the ambitus, as in *Paleopneustes Murrayi* A. Ag. Chall. Echini, far outside of the termination of the petals. There are large tubercles on the interambulacral plates between the petals extending to the peripetalous fasciole, arranged in more or less regular horizontal lines. Only fragments of the interambulacral areas near the abactinal system, nothing of the actinal surface of the test brought up. The primary tubercles carry long, stout, slightly curved spines.

(Sigsbee.) Off Havana. 242 fms.

Palæotropus Josephinæ Lovén.

(Sigsbee.) Off Havana. Lat. 22° 09′ N., Long. 82° 01′ W. 242 fms.
(Sigsbee.) Off Havana. 177 fms.

Paleopneustes cristatus A. Ag.

A young specimen, not more than one half an inch in length, was dredged in 175 fathoms, off Havana, by Captain Sigsbee. It differed in no way from the older specimens, except, of course, in having a smaller number of plates, but preserved all the characteristics of the larger specimens figured in the Hassler Expedition Echini.

(Sigsbee.) Off Havana. 175 fms.
(Sigsbee.) Off Havana Lat. 22° 11′ N., Long. 82° 21′ W. 242 – 450 fms.

Rhinobrissus micrasteroides A. Ag. spec. nov.

A small specimen of this genus, but half an inch in length, differing from the only other species of this genus in having its lateral ambulacra less sunken, a sharper, thinner peripetalous fasciole, a more vertically truncated posterior extremity. This species shows the affinity of the genus *Rhinobrissus* with *Micraster*, from which it differs in having a peripetalous fasciole and an anal branch of the subanal fasciole.

In alcohol the spines are of a greenish color. Anal plastron quite short, and wide ambulacral areas on the actinal side. Many of these characters will probably greatly change with age, and I merely allude to this interesting species, as it is, with the fragments of the genus allied to *Eupatagus*, another of the few genera of *Echinidæ* in common between the West-Indian and the Pacific Faunæ.

(Sigsbee.) Off Havana. 175 fms.

Brissopsis lyrifera Ag.

Station No. 49. Lat. 28° 51½′ N., Long. 89° 01½′ W. 118 fms.
(Sigsbee.) Off Havana. 122 – 240 fms.

Agassizia excentrica A. Ag.

Station No. 20, Lat. 23° 02.5′ N., Long. 83° 11′ W. 220 fms.
Station No. 36, Lat. 23° 13′ N., Long. 89° 10′ W. 86 fms.
Station No. 21, Lat. 23° 02′ N., Long. 83° 13′ W. 287 fms.
(Sigsbee.) Off Havana. Lat. 22° 09′ N., Long. 82° 11′ W. 242 fms.

Meoma ventricosa Lütk.

Station No. 10, Lat. 24° 44′ N., Long. 83° 26′ W. 37 fms.
Station No. 36, Lat. 23° 13′ N., Long. 89° 10′ W. 84 fms.
(Sigsbee.) Off Havana. 127 fms.

Schizaster (Periaster) limicola A. Ag. spec. nov.

Plate III.

Station No. 49, Lat. 28° 51½′ N., Long. 89° 01½′ W. 118 fms.

This species belongs to the generic group of *Schizaster*, separated as *Periaster* by D'Orbigny from the genuine *Schizaster*. Test quite globular, in outline from above angular, posterior extremity vertically truncated, slight keel between posterior petals near apex; anterior extremity truncated vertically from the edge of the peripetalous fasciole, with a shallow ambulacral groove. The lateral anterior petals are nearly twice as long as the posterior one, as well as broader. The petals are all about equally sunken. The peripetalous fasciole is in shape and position that of *Schizaster* proper, but there is no lateral fasciole extending under the anus, as in *Schizaster* proper; the anal fasciole is narrow, extending only a short distance on the sides of the test.

The test is thickly covered with primary tubercles of a uniform size, carrying short, slightly curved spines on the sides of test. The tubercles are more crowded within the fasciole and on the abactinal region of the odd posterior interambulacral area. The coronal plates between the fasciole and the anal system are quite bare, with few tubercles on the outer edges. On the actinal side the primary tubercles are larger, more distant, except on the actinal plastron, where they are closely crowded and carry longer, larger, and curved primary spines. The actinal lip is very sharp and prominent, one large row of exterior plates round the anterior edge of the actinostome, smaller, irregular plates within. Anal system quite small for such a large species. The separation of this group of *Schizaster* as a generic type seems very doubtful. It is based solely upon the more globular outline of the test and the discontinuity of the latero-anal fasciole. It may be convenient to form a subgeneric group with these characters; but when we get to such forms as *Sch. ventricosus* and *Sch. japonicus*, it certainly becomes very difficult, if not impossible, to draw the line of demarcation. We have something of the repetition of the numerous generic subdivisions attempted by Troschel in the genus *Tripylus* and its allied forms leading to *Faorina* and the like, while this is a deviation in the direction of such genera as *Periaster*, *Epiaster*, *Hemiaster*, and the like. The structure of the odd anterior ambulacrum of this species has all the characteristics of *Schi-*

zaster proper, namely, of such species as *Sch. canaliferus*, *Sch. fragilis*, *Sch. Philippii*, but has the outlines of *Hemiaster*, the fascioles of *Periaster*. It has but two genital openings. When brought up in the dredge, this species was of a dirty yellowish-brown color.

In order to retain for the Challenger Echini the priority, I did not intend to figure or fully describe in this paper any of the species previously dredged by the Challenger. From a preliminary examination of the two specimens brought home by the Challenger, I had, without having denuded the test, referred them to *Hemiaster*. My mistake I discovered only too late, after the plates of this paper were printed. As the figures represent specimens of a much larger size than those of the Challenger, they will not duplicate those to be given for the Challenger Echini.

In the vicinity of a thousand fathoms in depth and below it, we find in the Gulf of Mexico genera dredged by the Challenger in deep water in the Atlantic and Pacific, which appear to have an oceanic distribution, such as *Homolampas*, *Palæotropus*, *Aspidodiadema*, *Paleopneustes*, *Cœlopleurus*, *Salenia*, *Pourtalesia*, although some of these genera extend to a far less depth in the Gulf of Mexico, owing, however, to the special physical conditions of the Caribbean Sea and of the Gulf of Mexico. I will not attempt any general bathymetrical classification of the genera thus far obtained until after the dredgings of the coming season, which it is hoped will give us better material for a comparison of the deep-sea Caribbean Fauna with the collections of Echini brought home by the Challenger. As will be seen, the bathymetrical range of the new genera and species first collected by Mr. Pourtalès has been greatly extended, some of them reaching into the depths occupied by the strictly deep-sea forms mentioned above, which have a general distribution in the abyssal waters of the Atlantic and Pacific Oceans.

EXPLANATION OF THE PLATES OF ECHINI.

PLATES I. — II.

Conoclypus Sigsbei A. Ag.

PLATE I.

Fig. 1. Profile, seen facing the anterior extremity, natural size.
Fig. 2. Profile seen from the left side.

PLATE II.

Fig. 1. Seen from above, natural size.
Fig. 2. Seen from the actinal side, natural size.

PLATE III.

Periaster limicola A. Ag.

Fig. 1. Seen in profile.
Fig. 2. Seen from above.
Fig. 3. Seen from above, denuded.
Fig. 4. Seen from below, denuded.
All figures natural size.

PLATE IV.

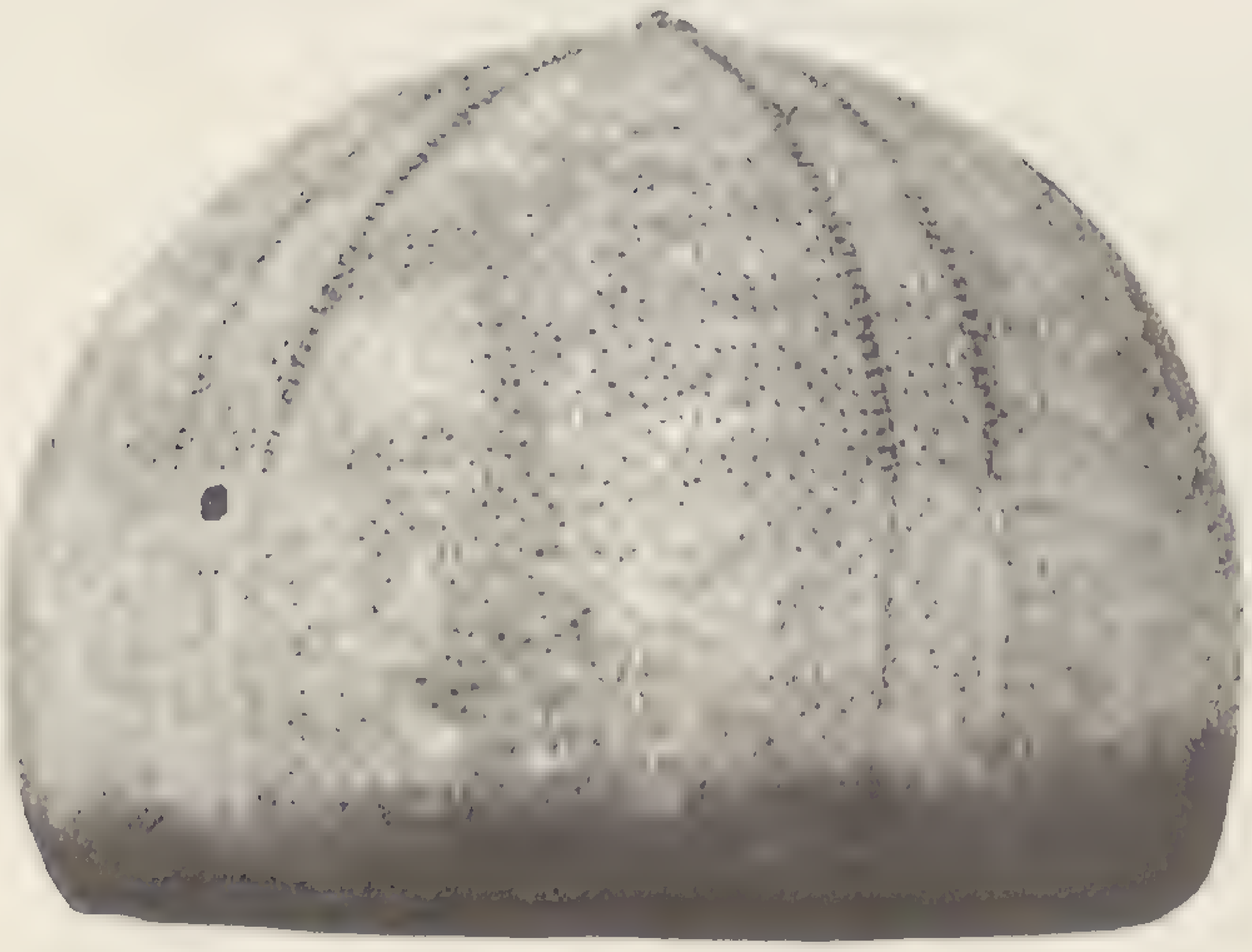
Dorocidaris Blakei A. Ag.

Fig. 1. Seen in profile.
Fig. 2. Seen from above.
Fig. 3. Seen from below.
All figures natural size.

PLATE V.

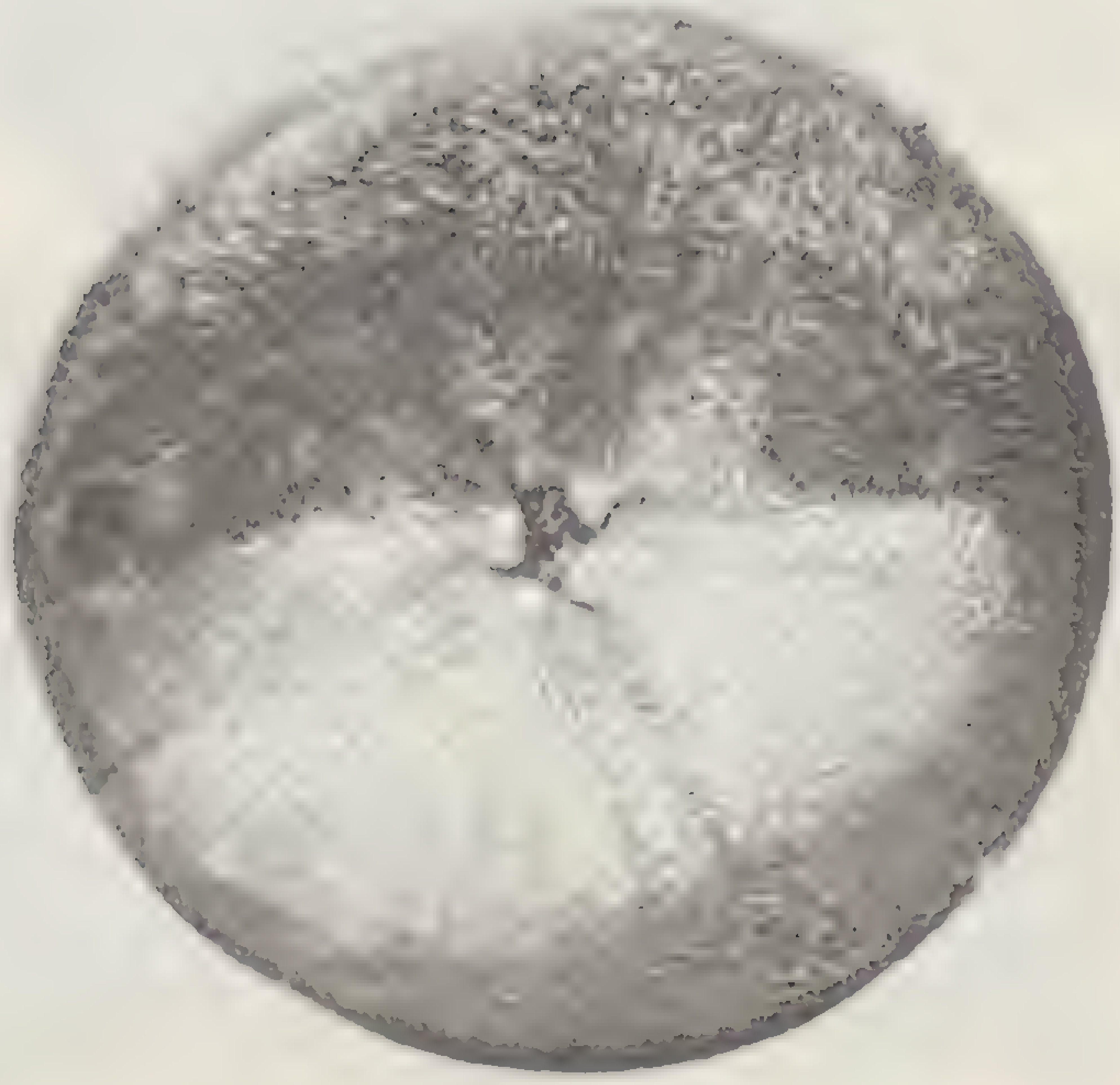
Salenia Pattersoni A. Ag.

Fig. 1. Seen in profile.
Fig. 2. Seen from above.
Fig. 3. Seen from the mouth side.
All figures natural size.



ALBERTYPE

HARROUN & BIERSTADT, N. Y.



ARTOTYPE, E. BIERSTADT, N. Y.

ALBERTYPE, HARROUN & BIERSTADT, N. Y.

Blake Exped. Echini

Plate V

CORALS.

THE rich collections made by Mr. A. Agassiz, in the United States steamer "Blake," Commander Sigsbee, U. S. N., in the southern and eastern part of the Gulf of Mexico, have yielded a number of interesting forms of deep-sea corals, in addition to most of those already described by me from those seas in former publications of the Museum. Mr. Agassiz's dredgings extended farther to the westward and southward and into greater depths than mine, thus giving a more complete view of the distribution of deep-sea corals in that sea. As far as our present knowledge goes, no sea-bottom can rival in abundance of deep-sea corals the West-Indian. It is not at all unfrequent for a single cast of the dredge to bring up a dozen different species, represented by more or less numerous specimens of each.

The larger number of the deep-sea corals of this region are found on the rocky bottom extending along the coast of Cuba and outside the Florida reefs, comparatively few being found in the *Globigerina* ooze of the greater depths of the gulf and of the Florida straits. I have had occasion before to remark on some differences in the distribution on the two sides. As the coral fauna of the extremity of the Florida peninsula is a colony of the West-Indian, of comparatively recent origin, it is not surprising that some forms have not borne the transportation, or failed to propagate in the new habitat for some cause or other. I feel tolerably certain of it in the case of *Pentacrinus*, the presence of which in a region is so generally revealed by the numerous joints of the stem found in the débris of the bottom. It is more difficult to account for the absence or rarity on the coast of Cuba of forms very abundant on the Florida side. Thus Mr. Agassiz obtained but few specimens of *Terebratula cubensis* and *Waldheimia floridana*, which were almost a nuisance in my dredge on the Florida coast. The same remark will apply to *Balanophyllia floridana*, *Thecopsammia tintinnabulum*, *Rhizotrochus fragilis*, *Distichopora foliacea*, *Allopora miniacea*, and a few others rare in Cuban waters, common on the other side.

It is to be regretted that no additional specimen of the singular *Haplophyllia paradoxa* was obtained; there is not even a fragment that can be referred to it.

LIST OF SPECIES, WITH REMARKS AND DESCRIPTIONS OF NEW FORMS.

MADREPORARIA.

CARYOPHYLLIA.

A number of specimens referable to this genus are in the collection, the majority, however, in immature or imperfect condition, so that, with the well-known variability in this genus, it would be a thankless labor to attempt identification. The following species I still think can be retained in the West-Indian fauna as well characterized: *Caryophyllia clavus, formosa, berteriana, cornuformis,* and *antillarum,* to which I add a new one, *C. polygona.* *C. berteriana,* so abundant at Barbadoes, is not represented in the present collection by any undoubted specimens. *C. antillarum* is rare. Of *C. formosa* there are two fine specimens from 95 fathoms on the edge of the Yucatan bank, and a number of young specimens from various localities can probably be referred to this species. *C. cornuformis* is represented by several dead and worn specimens and two fresh ones from 310 fathoms, off Bahia Honda, Cuba; they are mostly larger than those described in my "Deep-Sea Corals." I must correct here my former description, which mentioned four cycles, with the pali in front of the secondary. There are only three, and thus there is no anomaly in the arrangement of the pali, which are in front of the penultimate cycle. The figure on Plate I. was correct, and I cannot account now for my mistake in the text. In a very old specimen there appear to be some additional septa, probably of the fourth order, but the specimen is too much worn for study. *C. Pourtalesi* Duncan is probably identical with this species.

Caryophyllia polygona Pourt. spec. nov.

Corallum fixed by a stout peduncle, rather massive. Primary and secondary costæ very prominent, subcristiform, and extending down to the peduncle, those of the younger cycles very faint in the younger specimen, entirely obsolete in the older, which has also lost most of the granulation visible in the former on the peduncle and near the border. Calicle oblong, wall thick; septa thick, smooth or very faintly granulated. Four complete cycles and six systems; in the larger specimen the fifth cycle is fully developed in one of the half-systems. Primary and secondary septa nearly equal, exsert; twelve pali fronting the tertiaries. Columella formed by seven or eight twisted lamellæ in

two rows. Height of larger, 24 mm.; greater diameter of calicle, 15 mm., lesser, 12 mm.

Two specimens were obtained, both attached to the same stem of a species of *Primnoa*. They agree in most of the characters, though differing somewhat in general appearance. The species appears related to *C. peloritana* and *angulosa* of Seguenza, from the miocene of Sicily.

Station No. 41. Lat. 23° 42′ N., Long. 83° 13′ W. 860 fms.

Caryophyllia formosa Pourt.

Station No. 32. Lat. 23° 52′ N., Long. 88° 5′ W. 95 fms.
" " 20. Lat. 23° 2′ N., Long. 83° 11′ W. 220 fms.

Caryophyllia antillarum Pourt.

Station No. 44. Lat. 25° 33′ N., Long. 84° 35′ W. 539 fms.

Caryophyllia cornuformis Pourt.

Station No. 19. Lat. 23° 3′ N., Long. 83° 10′ W. 310 fms.

Caryophyllia (fragments and young).

Station No. 32. Lat. 23° 52′ N., Long. 88° 5′ W. 95 fms.
" " 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.
" " 20. Lat. 23° 25′ N., Long. 83° 11′ W. 220 fms.
(Sigsbee.) Off Havana. 80 – 100 fms.
" Off Havana. 243 – 450 fms.
Station No. 21. Lat. 23° 2′ N., Long. 83° 13′ W. 287 fms.
" " 19. Lat. 23° 3′ N., Long. 83° 10′ W. 310 fms.
" " 2. Off Havana. 805 fms.
" " 46. Lat. 25° 43′ N., Long. 84° 47′ W. 888 fms.

Trochocyathus Rawsonii Pourt.

A number of fine specimens, living and dead, were dredged in 95 fathoms off Bahia Honda, Cuba. They reach a diameter of 15 – 17 mm., the height being about the same. There is no possibility of identity of this species with *Deltocyathus Agassizii*, as supposed by Lindström, though there is very little doubt that the two genera can scarcely be kept separate. Some of the specimens are attached by a small peduncle, while others are completely free. A few, not otherwise distinguishable, are covered by a complete epitheca. The specimens figured in Ill. Cat. Mus. Comp. Zoöl., No. VIII. Part I. Pl. VI., were young ones.

Station No. 32. Lat. 23° 52′ N., Long. 88° 5′ W. 95 fms.
(Sigsbee.) Lat. 26° 31′ N., Long. 85° 3′ W. 119 fms.
" Off Havana. 175 fms.
" Off Havana. 243 – 458 fms.
" No. 2. Off Havana. 805 fms.

Deltocyathus Agassizii Pourt.

About 375 specimens were obtained, ranging in depth from 84 to 888 fathoms. They can be classed into two varieties, *equicostatus* and *calcar*, passing into each other through an intermediate one having the thicker primary costæ of calcar, but no projecting spurs. Some of these appear to have had the spurs at one period of their growth, but not to have kept them when full grown. One specimen has the earlier stage decidedly of the calcar variety, and then suddenly has become equicostate for the rest of its growth. There is no decided preponderance of one variety over the other due to depth, but sometimes a cast of the dredge brings only one variety, sometimes both in about equal numbers. Of the many hundred West-Indian specimens I have examined, none have shown any trace of adherence, even when so young as to have a diameter of but one or two millimeters. I regret that want of room prevents me from giving figures of a selection from numerous mutilated and mended specimens, showing that the genera *Ecmesus* Philippi, *Hemicyathus* Seguenza, and the *Genus incertæ sedis* of Professor Duncan are nothing but similar individuals of *Deltocyathus* and sometimes of *Diaseris*.

Station No. 36. Lat. 23° 13′ N., Long. 89° 10′ W. 84 fms.
" " 32. Lat. 23° 52′ N., Long. 88° 5′ W. 95 fms.
(Sigsbee.) Off Havana. 100 fms.
" Off Sand Key, Fla. 111 fms.
" Lat. 26° 31′ N., Long. 85° 3′ W. 119 fms.
" Off Havana. 158 fms.
" Off Havana. 175 fms.
" Lat. 22° 9′ N., Long. 82° 21′ W. 177 fms.
Station No. 20. Lat. 23° 25′ N., Long. 83° 11′ W. 220 fms.
" " 3. Off Havana. 243 fms.
(Sigsbee.) Off Havana. 458 fms.
Station No. 21. Lat. 23° 2′ N., Long. 83° 11′ W. 287 fms.
" " 19. Lat. 23° 3′ N., Long. 83° 10′ W. 310 fms.
" " 2. Off Havana. 805 fms.
" " 46. Lat. 25° 43′ N., Long. 84° 47′ W. 888 fms.

Paracyathus De Filippii D & M.

Telegraph cable, off Sand Key, Fla. 45 fms.
Off Havana. 80 fms.
Station No. 32. Lat. 28° 52′ N., Long. 88° 5′ W. 95 fms.
" " 22. Lat. 23° 1′ N., Long. 83° 14′ W. 100 fms.
" " 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.
(Sigsbee.) Lat. 26° 31′ N., Long. 85° 3′ W. 119 fms.
Station No. 23. Lat. 23° 1′ N., Long. 83° 14′ W. 190 fms.
" " 2. Off Havana. 805 fms.

Paracyathus flos Pourt. spec. nov.

Corallum broadly attached, short, expanding rapidly and widely. Costæ flat, distinct to the base, somewhat unequal, densely granulated. Septa very exsert, rounded or subangular with rounded corners, thickened in the middle, thus having a lenticular section, covered with granules, which are not arranged in any particular order. Four cycles, the fourth wanting in a few half-systems. Primary and secondary septa nearly equal, the first advancing somewhat more towards the centre. Pali very irregular in size, smallest in front of the primaries, largest sometimes forming two lobes in front of tertiaries. The pali surround a very deep and narrow fossa, at the bottom of which is seen the columella formed of 5 or 6 stout papillæ. The septa are horn-colored with darker border, the pali and columella are pure white. Height, 7 mm.; diameter of stem, 3 mm.; of calicle, 10 mm. Only one specimen and fragments of another were obtained.

This coral differs very much in general appearance from the typical *Paracyathi;* at first glance it would be taken for a stunted *Caryophyllia,* but the characters, strictly taken, place it undoubtedly in the former genus.

Station No. 5. Off Havana. 100 fms.

Leptocyathus Stimpsonii Pourt.

Fine and large specimens were obtained in 119 fathoms on the Florida bank, of the type first described and figured by me. In the Florida straits in 229 fathoms quite a number were dredged of the more elongated shape, which Mr. Lindström has found to be the prevalent form in the eastern Atlantic. The two might perhaps be separated specifically, as in the elongated form the costæ are flat, finely granulated, separated by very small furrows; in the spherical form they are sharp, with very deep furrows, covered with very small spines, and pass over into the septa without differentiation; in the elongated form the edge of the calicle is, on the contrary, more or less sharply defined. Still, in the light of the great variability of some of the forms of corals, it is safer to leave the two forms together for the present. I now refer to this species *Stephanophyllia folliculus* P., or *Paracyathus folliculus* P.

Mr. Lindström doubts the propriety of referring these corals to the genus *Leptocyathus,* although he adopts the reference provisionally. He did not recognize the pali, which, however, I find quite distinct in large specimens, in front of the tertiaries, but I have had no opportunity of direct comparison with the fossil species.

(Sigsbee.) Lat. 26° 31′ N., Long. 85° 3′ W. 119 fms.
" Off Havana. 175 fms.
Station No. 20. Lat. 23° 25′ N., Long. 83° 11′ W. 220 fms.
(Sigsbee.) Lat. 24° 16′ N., Long. 82° 13′ W. 229 fms.
" Off Havana. 243–450 fms.

Stenocyathus vermiformis Pourt.

Station No. 5. Lat. 24° 16′ N., Long. 82° 13′ W. 152 – 229 fms.
(Sigsbee.) Off Havana. 243 - 450 fms.

Thecocyathus lævigatus Pourt.

Station No. 5. Lat. 24° 16′ N., Long. 82° 13′ W. 229 fms.
" " 19. Lat. 23° 3′ N., Long. 83° 10′ W. 310 fms.

Thecocyathus recurvatus Pourt. spec. nov.

Corallum conical, pedicellate, free when full grown, curved at base, covered by a thin, pellicular, wrinkled epitheca, extending to the border of the calicle; the costæ can be distinguished through it. Septa very slightly exsert, rounded, granulated, somewhat plicated near the edge; in six equal systems, having the fourth cycle developed in only a part of them. Pali thick, conical, in front of the septa of the first, second, and third order, wanting, however, in front of those of the third in the half-systems lacking the fourth order. Columella composed of about ten papillæ, very similar to the pali, and on the same level with them. Height, 8 mm.; diameter of calicle, 6 mm.

(Sigsbee.) Off Havana. 175 fms.

Conotrochus typus Seg.

A young specimen from 292 fathoms off Havana was at first doubtfully referred to this species, but afterwards an adult one was found among the corals dredged by Dr. Stimpson in the Gulf of Mexico. (Depth and exact locality not recorded.) There is no striking difference from the European fossil, which is well figured by Seguenza and by Reuss. The columella is somewhat more loose and composed of fewer papillæ. The larger specimen has the systems, which are regular in the young, somewhat incompletely developed, as is the case in the fossil. Younger. 12 mm. long; diameter of calicle, 3 mm. Larger, 24 mm. long; diameter of calicle, 10 mm.

Station No. 16. Off Havana. 292 fms.

Ceratotrochus hispidus Pourt. spec. nov.

Plate I. Figs. 19, 20.

Corallum attached by a slender peduncle, rather elongated turbinate; costæ ornamented with short and thick hirsute spines; calicle circular; three complete cycles, six regular systems. Septa not exsert, rounded, granulated with inner border re-entering below. Columella formed of about 10 papillæ, not very dense. Height, 1 cm.; diameter of calicle, 5 mm. One single specimen was obtained, and this is, as far as I am aware, the first representative of this genus found living.

Station No. 19. Lat. 23° 3′ N., Long. 83° 10′ W. 310 fms.

Rhizotrochus fragilis Pourt.

Station No. 36. Lat. 23° 13′ N., Long. 89° 10′ W. 84 fms.
" " 32. Lat. 23° 52′ N., Long. 88° 5′ W. 95 fms.
(Sigsbee.) Lat. 26° 31′ N., Long. 85° 3′ W. 119 fms.

Rhizotrochus tulipa Pourt.

(Sigsbee.) Off Havana. 175 fms.

Flabellum angulare Moseley.

The specimen has six systems, but otherwise agrees with Moseley's specimen, which had only five.

Station No. 46. Lat. 25° 43′ N., Long. 84° 47′ W. 888 fms.

Desmophyllum Cailleti D. & M.

Station No. 36. Lat. 23° 13′ N., Long. 89° 16′ W. 84 fms.
" " 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.
Off Havana. 175 fms.
(Sigsbee.) Station No. 11. Lat. 22° 9′ N., Long. 82° 21′ W. 242 fms.

Desmophyllum cristagalli M. Edw. & H.

A fine specimen and a younger one on a stem of *Primnoa* from 805 fathoms, 4 miles from Havana. *D. reflexum* and *Riisei* D. & M. may be only the young of this species. *D. Cailleti* D. & M. is well characterized by its smooth outside.

(Sigsbee.) Off Havana. 100 fms.
" Station No. 9. Off Havana. 127 fms.
" Off Havana. 158 fms.
Station No. 2. Off Havana. 805 fms.

Turbinolia corbicula Pourt. spec. nov.

Plate I. Figs. 12, 13.

Turbinate, somewhat attenuate towards the base and swelled out in the middle. Costæ covered with very fine sharp granulations, giving the whole outside a hispid appearance. The costæ of the two first orders equal, those of the third cycle broader and flatter. The mural pits rather large and numerous, partly covered by the small spines. Calicle circular. Septa in two cycles only, without trace of the third, hardly exsert, finely granulated. Columella ill-defined and not prominent. Height, 3 mm.; diameter, 2 mm. None of the specimens were living. Perhaps fossil (?).

Station No. 19. Lat. 23° 3′ N., Long. 83° 10′ W. 100 fms.
" " 20. Lat. 23° 2′ N., Long. 83° 11′ W. 220 fms.

Schizocyathus fissilis Pourt.

(Sigsbee.) Off Havana. 243 – 450 fms.

Oculina tenella Pourt.

Station No. 10. Lat. 24° 44′ N., Long. 83° 26′ W. 37 fms.
" " 11. Lat. 24° 43′ N., Long. 83° 25′ W. 37 fms.

Lophohelia exigua Pourt.

A number of specimens were obtained in 100 fathoms on the western edge of the Florida bank; they show no variation from the type.

Station No. 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.

Amphihelia sculpta Seg.

Off Havana. 158 fms.
Off Havana. 480 fms.
Station No. 15. Off Havana. 785 fms.
" " 2. Off Havana. 805 fms.

Rather numerous specimens of an *Amphihelia*, agreeing with Seguenza's species better than with any of the varieties of *Amphihelia ramea* figured by Professor Duncan, were dredged in this locality.

Amphihelia rostrata Pourt. spec. nov.

Plate I. Figs. 4, 5.

Corallum flabellate, with all the calicles facing one way; cœnenchyma dense, finely striated in all parts, the striæ finely spinose and formed by the continuation of the costæ. The calicles at first rather long infundibuliform, the young rising singly or in pairs from the border of the older ones. On the older branches the calicles are irregularly alternate and but little prominent. Three cycles of septa, in six systems, with entire edges. Primaries and secondaries equal and reaching the loosely spongy columella; tertiaries smaller. One of the primary septa, generally on the side opposite to the branch, is very much thickened, and projects with its costal part outside the calicle in the shape of a rounded spur about 2 mm. long. This appendage is entirely disconnected from the budding process, which always takes place on the opposite side, or nearly so. This elegant coral must have had a spread, when entire, of about 12 cm. Diameter of thickest branches, 5 or 6 mm.; of calicles, 3 to 4 mm. The polyps seem to have been of a pinkish color when alive. The cœnenchyma is pure white.

Station No. 2. Off Havana. 805 fms.

Madracis asperula M. Edw. & H.

Station No. 10. Lat. 24° 44′ N., Long. 83° 25′ W. 37 fms.

Axohelia dumetosa Duch.

Off Havana. 80 fms.
Station No. 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.
Off Havana. 175 fms.
Station No. 21. Lat. 23° 2′ N., Long. 83° 11′ W. 287 fms.

Cladocora debilis M. Edw. & H.

Station No. 12. Lat. 24° 34′ N., Long. 83° 16′ W. 36 fms.
" " 11. Lat. 24° 43′ N., Long. 83° 25′ W. 37 fms.

ANTHEMIPHYLLIA Pourt. gen. nov.

Corallum free or pedicellate, with rudimentary epitheca, no columella; septa thick and having the edge beset with transversely flattened processes. It is allied to *Leptophyllia* and *Montlivaultia*, but differs from them chiefly by the mode of division of the border of the septa, which in these generally consists in simple spines.

Anthemiphyllia patera Pourt. spec. nov.

Plate I. Figs. 14, 15.

Short turbinate or saucer shaped, free, but showing former adherence to small fragment of shell. Epitheca very rudimentary. Costæ distinct to the base, covered with small spines or sharp tubercles. Calicle circular, fossa shallow. Six complete systems of septa, four cycles. Those of the first, second, and third cycle nearly equal, the fourth much smaller. The septa are broadest about the middle, becoming thinner towards the centre and circumference of the calicle. Their border is thickly beset with spiny flattened processes, standing at right angles to the plane of the septum. Towards the centre the septa become indistinct and the processes smaller and denser, forming a false columella without definite limits. The interseptal spaces have a tendency to become filled up by the endotheca, particularly near the centre.

The structure of the spines of the septa is very different from that of the ordinary *Lithophyllidæ*, where they are sharp and flattened in the plane of the septum.

Height of specimen, 5 mm.; diameter, 9 mm. Only one was obtained.

Station No. 16. Off Havana. 292 fms.

Montlivaultia poculum Pourt. spec. nov.

Plate I. Figs. 21, 22.

Conical, free; epitheca thin, costæ finely granular. Calicle very slightly elliptical, fossa deep. Septa alternately large and small, fifty-eight in number, the twenty-nine large ones equal and all reaching the centre, very little exsert and sparsely granulated, and showing no difference of cycles or distinct systems. The small septa reach only half-way. The upper edge of the septa is entire. The larger ones gradually become lobed, until towards the centre of the calicle they send forth a number of blunt lobes, filling the bottom of the fossa. No columella. The interseptal chambers are deep; the dissepiments cannot be made out without a section. Height, 3 cm.; diameter of calicle, 22 mm.

This coral was found among the specimens dredged by the late Dr. Stimpson,

but without label. As most of his dredgings were made off the west coast of Florida, this may be considered the most probable locality. It was evidently dead when dredged, and possibly may be a fossil from some submarine bed; to this, however, the perfect condition of the most delicate parts and the entire absence of foreign matter in the interseptal chambers seem to present objection.

Parasmilia fecunda Lindstr.

(*Cœlosmilia fecunda* Pourt.)

This somewhat puzzling form can well remain for the present in the genus *Parasmilia*, as Mr. Lindström proposes. Except for the buds, it resembles very closely some of the cretaceous forms, as *Parasmilia centralis* or *serpentina*. Professor Duncan and Mr. Studer have proposed new generic names for it. In point of date Mr. Studer's name, *Anomocora*, will precede *Blastosmilia* Dunc., if it is adopted.

Station No. 32. Lat. 23° 52′ N., Long. 88° 5′ W. 95 fms.
" " 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.
(Sigsbee.) Off Havana. 175 fms.
Station No. 24. Lat. 23° 2′ N., Long. 83° 13′ W. 342 fms.

Parasmilia arbuscula Pourt.

(*Cœnosmilia arbuscula* Pourt.)

(Sigsbee.) Off Havana. 80 fms.
Station No. 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.
(Sigsbee.) Off Havana. 175 fms.
" Off Havana. 242 fms.

Solenosmilia variabilis Dunc.

Plate I. Figs. 1, 2, 3.

Professor Duncan's figures do not render the remarkable process of fissiparity of the terminal calicles of this coral, of which two stages are represented on Pl. I.

Station No. 2. Off Havana. 805 fms.

Colangia simplex Pourt. spec. nov.

Plate I. Figs. 18, 18 *a*.

Corallum cylindrical, rising from an expanded base (perhaps connecting with other corallites). Epitheca thick, rising above the border of the calicle, hiding all trace of costæ. Calicle circular, fossa deep. Septa rather thick, but little granulated; three cycles and a few septa of the fourth. The primaries rounded, entire, but little exsert, somewhat wavy in the lower part; secondaries lower, having the internal border divided into three or four strong, blunt teeth, and having a stout paliform lobe slightly elevated above the columella. Tertiaries lobed like the secondaries. Columella well developed, formed of fifteen or more stout papillæ, arranged in three rows, of which the middle one is best

developed. A very young specimen has the tertiaries formed by a few spines projecting from the wall, the columella has fewer papillæ, and the pali are only beginning to form. Larger specimen 16 mm. high and 1 cm. in diameter.

It is referred to this genus with some doubt, but its systematic position is near it.

(Sigsbee.) Off Havana. 80 fms.
Station No. 22. Lat. 23° 1′ N., Long. 83° 14′ W. 100 fms.

Cylicia inflata Pourt. spec. nov.

Plate I. Figs. 10, 11.

Corallum forming small, loose clusters, connected by a smooth expansion of the epitheca, which is considerably thickened, very smooth, but has no distinct border. The corallites are conical, slightly bulging below, having thus an inflated appearance. Calicle small, circular, very deep. Columella papillose, well developed. Septa in three cycles and six systems. Primaries entire, secondaries lobed below, the lowest lobes in form of stout pali, considerably raised above the columella. Tertiaries very small. Height, 3 mm.; diameter of calicle, 1 mm.

(Sigsbee.) Off Havana. 100 fms.
" Off Havana. 242 fms.

Balanophyllia floridana Pourt.

(Sigsbee.) Off Sand Key, Fla., on telegraph cable. 50 fms.
" Off Havana. 80 – 100 fms.

Balanophyllia palifera Pourt. spec. nov.

Conical, attached, with thin pellicular epitheca; costæ of the usual form in the genus. Calicle slightly elliptical. Septa in six complete systems, four cycles; primaries thick and prominent. Tertiaries very small and thin. Pali stout and prominent, in front of the tertiaries and inside the junction of the septa of the fourth cycle with the former. Columella well developed and spongy. About 15 mm. high. A specimen dredged off Barbadoes in 100 fathoms was figured in Ill. Cat. Mus. Zoöl. No. VIII. Pl. VI. Fig. 20 under the name of *B. floridana*, which it resembles most. The pali are an anomaly in the family, though the part representing them is mostly present, though not thickened or elevated.

Station No. 12. Lat. 24° 34′ N., Long. 83° 16′ W. 36 fms.
(Sigsbee.) Off Havana. 243 – 458 fms.

Thecopsammia tintinnabulum Pourt.

Station No. 5. Lat. 24° 16′ N., Long. 82° 13′ W. 152 – 229 fms.
" " 44. Lat. 25° 33′ N., Long. 84° 35′ W. 539 fms.

Dendrophyllia profunda.

(*Diplohelia profunda* POURT.)

Plate I. Figs. 6-8.

A well-preserved specimen shows that I had mistaken the genus in describing this species. The family characters are indeed quite obscure, and only apparent in very young calicles, or at the bottom of the older ones. In the present specimen the calicles are much more prominent than in the one formerly described. The border of the calicle is vermiculated and porous to a very slight degree, easily overlooked. The septa are entire in the upper part, finely serrate in the lower. Its nearest ally is *Cœnopsammia scillæ* Seg. I follow Professor Verrill in joining *Cœnopsammia* to *Dendrophyllia.*

Station No. 44. Lat. 25° 33′ N., Long. 84° 35′ W. 539 fms.
" " 2. 4 miles from Morro Light. 805 fms.

Dendrophyllia cyathoides POURT.

(Sigsbee.) Station No. 5. Off Havana. 100 fms.

TROCHOPSAMMIA POURT. gen. nov.

Balanophylliæ with non-coalescent septa and rudimentary or absent columella.

Trochopsammia infundibulum POURT. spec. nov.

Plate I. Figs. 16, 17.

Turbinate, fixed, covered by a thickened epitheca near base. Costæ thick and flattened, with scattered pores, which are more abundant in the furrows. Wall thin. Calicle almost circular; septa in six complete systems, three cycles, nearly equal, extending down to the bottom where they join into a rudimentary columella. Towards the bottom the tertiaries approximate slightly towards the secondaries without actually coalescing. At the border of the calicle the septa are much thickened and vermiculated; farther down they are thin and sparsely dentate, but appear to thicken with age. Height, 10 to 11 mm. Diameter of calicle, 7 to 8 mm.

Station No. 25. Lat. 83° 12′ N., Long. 23° 4′ W. 635 fms.
" " 2. Off Havana. 805 fms.

Fungia symmetrica POURT.*

(Sigsbee.) Off Havana. 175 fms.
" Lat. 23° 25′ N., Long. 83° 11′ W. 220 fms.
" Off Havana. 243-458 fms.
" Lat. 23° 2′ N., Long. 83° 11′ W. 287 fms.
Station No. 2. Off Havana. 805 fms.

* "This species has been proved by our dredgings to be one of the most constantly recurring of deep-sea animals, with a world-wide distribution. . . . It oc-

Diaseris crispa Pourt.

(Sigsbee.) Lat. 26° 31′ N., Long. 85° 3′ W. 119 fms.

Guynia annulata Dunc.

Station No. 22. Lat. 23° 1′ N., Long. 83° 14′ W. 100 fms.

ANTIPATHARIA.

The following species were collected.

Antipathes (Cirrhipathes) Desbonnii Duch & Mich.

The describers lay particular stress on this species not forming a spiral; our specimens are, however, always in that form. The axis has six rows of spines. The polyps are placed so as to cover four of the rows; they are large, crowded, and, as I have remarked in a former paper, are alternately, but not regularly, large and small. Eggs were found in one of the larger ones, thus rendering it probable that they and the smaller ones are of different sexes. The tentacles are large and fleshy, but in the polyps near the base of the stem they become obsolete, although the mouths can be plainly distinguished.

Those from greater depths are by far the largest, reaching a length of 1.3 m. with a diameter at base of only 2.5 mm.

(Sigsbee.) Off Sand Key, Fla. On telegraph cable. 45 fms.
Station No. 36. Lat. 23° 13′ N., Long. 89° 10′ W. 84 fms.
(Sigsbee.) Off Havana. 127 fms.
Station No. 35. Lat. 23° 52′ N., Long. 88° 58′ W. 804 fms.

Antipathes (Arachnopathes) columnaris Duch.

The polyps are small and difficult to see; they are of the sessile type, the tentacles appearing only as small knobs disposed in three pairs on the branchlets, but are spread out on the stem. Two specimens in the number are destitute of the parasitic worm and of the tube produced by it; their branchlets are more spiny, but the general shape is the same.

Station No. 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.
" " 26. Lat. 24° 37′ N., Long. 83° 36′ W. 110 fms.

curred in the North and South Atlantic, near the ice barrier in the Southern Sea, off the West Indies, in the North and South Pacific Oceans, and among the Moluccas. It has a more extended range in depth than almost any other animal, having been obtained by us in thirty fathoms off Bermudas, and at all intermediate depths down to 2,900 fathoms. . . . . It occurs on all kinds of bottom. . . . . It sustains a range of temperature from 1° to 20° C." (Sir Wyville Thomson in "The Voyage of the Challenger.")

Antipathes tristis Duch.

Station No. 26. Lat. 24° 37′ N., Long. 83° 36′ W. 110 fms.

Antipathes myriophylla Pallas.

The specimens agree with Esper's figure on Pl. X. Pallas gives the East Indies and America as the habitat; there are probably two species, as a specimen in this Museum from Singapore has a general resemblance, but is not pectinate or pinnate like this one. The polyps are of the sessile type.

Station No. 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.
" " 4. (Sigsbee.) Off Havana. 242 fms.

Antipathes abietina Pourt.

Station No. 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.

Antipathes humilis Pourt.

Station No. 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.

HYDROIDS.

Family of STYLASTERIDÆ.

Stylaster filogranus Pourt.

(Sigsbee.) Off Havana. 175 fms.

Stylaster erubescens Pourt.

Station No. 44. Lat. 25° 33′ N., Long. 84° 35′ W. 539 fms.

Stylaster punctatus Pourt.

(Sigsbee.) Off Havana. 80 fms.
Station No. 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.

Stylaster complanatus Pourt.

Station No. 5. Off Havana. 100 fms.
(Sigsbee.) Off Havana. 154 fms.
" Off Havana. 175 fms.
" Off Havana. 292 fms.
" Off Havana. 245 – 458 fms.

Distichopora sulcata Pourt.

(Sigsbee.) Off Havana. 80 fms.

Distichopora contorta Pourt. spec. nov.

Plate I. Fig. 9.

Corallum branching, subflabellate; surface very finely granulated and ridged. The stem is nearly cylindrical, the branches but little compressed.

The rows of calicles are very irregular, generally forming a broad, flat furrow, with the pores for the tentacular zooids rather removed and in the form of small transverse slits on the side of a ridge, as in *D. cervina*. The branches grow out from one edge of the furrow, causing the latter to widen out and the other edge to extend across the new-formed branch. Sometimes the rows of calicles become double. The only specimen obtained has very few and indistinct gonophores. Color whitish ; height 45 mm.

This species differs, by its peculiar mode of branching, from all the other representatives of the genus in our collections.

(Sigsbee.) Station No. 14. Off Havana. 175 fms.

Cryptohelia Peircii Pourt.

Station No. 5. Off Havana. 100 fms.
" " 44. Lat. 25° 33′ N., Long. 84° 35′ W. 539 fms.

Lepidopora glabra Pourt.

(Sigsbee.) Station No. 5. Off Havana. 100 – 154 fms.
" Off Havana. 158 fms.
" Off Havana. 243 – 458 fms.

Lepidopora cochleata Pourt.

(Sigsbee.) Off Havana. 154 fms.
Station No. 16. Off Havana. 292 fms.

Errina carinata Pourt.

(Sigsbee.) Station No. 5. Off Havana. 80 – 100 fms.
" Off Havana. 292 fms.

Pliobothrus tubulatus Pourt.

Station No. 16. Lat. 23° 11′ N., Long. 82° 23′ W. 292 fms.

Pliobothrus symmetricus Pourt.

Station No. 5. Lat. 24° 16′ N., Long. 82° 13′ W. 229 fms.

Note. The Favosites mentioned in Mr. Agassiz's letter No 1. (Bull. Mus. Comp. Zoöl. Vol. V. No. 1) proves, on examination of its internal structure, to be quite different. Being dry, the soft parts could not be examined satisfactorily. Mr. Moseley, who has examined a portion of it, expresses a strong suspicion that it is a Bryozoon, perhaps related to some mushroom-shaped Bryozoa in the "Challenger" collection. A description will be deferred until after next season's dredgings, in the hope of obtaining some alcoholic specimens.

EXPLANATION OF THE PLATE.

PLATE I.

Fig. 1. **Solenosmilia variabilis** DUNCAN. Natural size.

Fig. 2. " " A calicle showing first traces of division, magnified.

Fig. 3. " " A calicle farther advanced in the process of division, two sides bending over and meeting in the middle. Magnified.

Fig. 4. **Amphihelia rostrata** POURT. Natural size.

Fig. 5. " " Calicle, magnified.

Fig. 6. **Dendrophyllia profunda** POURT. Natural size.

Fig. 7. " " Calicle, magnified.

Fig. 8. " " Section of young calicle, magnified.

Fig. 9. **Distichopora contorta** POURT. Natural size.

Fig. 10. **Cylicia inflata.** Natural size.

Fig. 11. " " Calicle, magnified.

Fig. 12. **Turbinolia corbicula** POURT. Calicle, magnified.

Fig. 13. " " Side view, magnified.

Fig. 14. **Anthemiphyllia patera** POURT. Calicle, magnified.

Fig. 15. " " Side view, magnified.

Fig. 16. **Trochopsammia infundibulum** POURT. Calicle, magnified.

Fig. 17. " " Side view, magnified.

Fig. 18. **Colangia simplex** POURT. Side view, magnified.

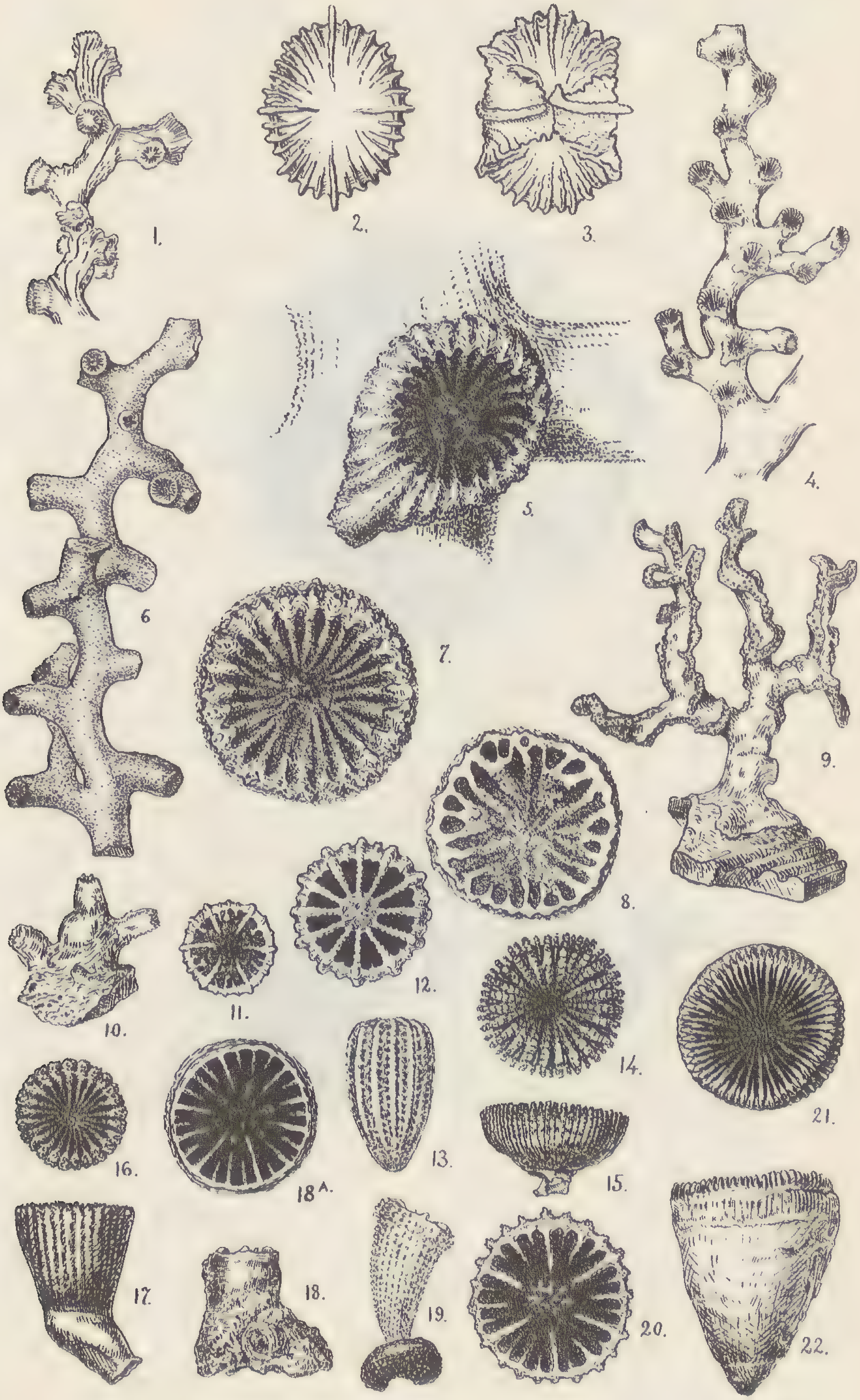
Fig. 18*a*. " " Calicle, magnified.

Fig. 19. **Ceratotrochus hispidus** POURT. Side view, magnified.

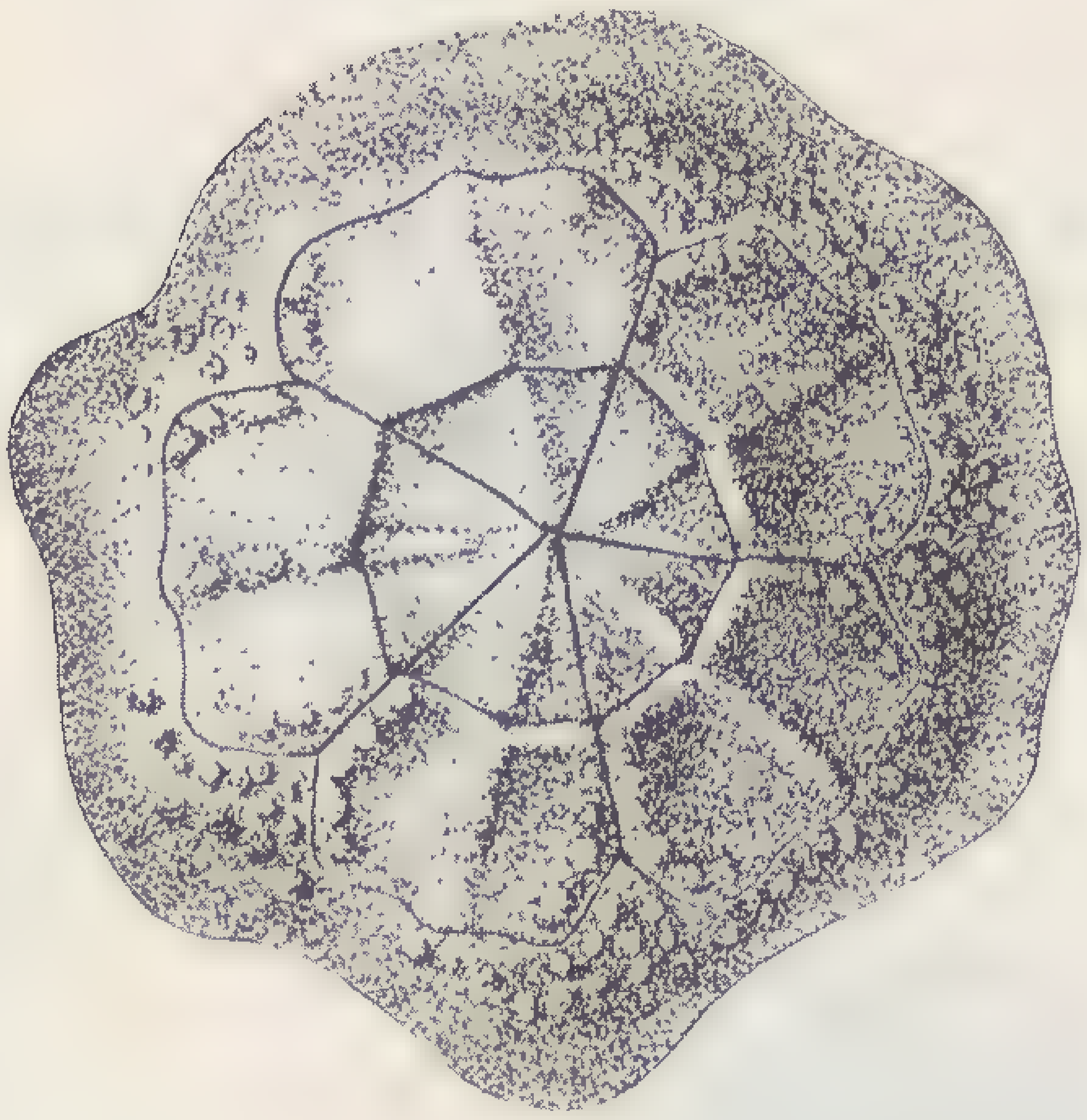
Fig. 20. " " Calicle, magnified.

Fig. 21. **Montlivaultia poculum** POURT. Side view, natural size.

Fig. 22. " " Calicle, natural size.



J. Henry Blake, ad nat.



J. Henry Blake from A. Agassiz

DESCRIPTION OF A YOUNG HOLOPUS.

A VERY young specimen of Holopus was dredged in the "Blake" Expedition in Lat. 23° 1′ N., Long. 83° 14′ W. Depth 100 fathoms. It has been sent to Professor Sir Wyville Thomson for study, but was previously drawn by Mr. Agassiz for the accompanying plate.

The specimen is attached to a piece of rock, and was not detected until it had become dry. The general shape is a truncated cone when contracted, with irregular contour of attachment. The body part is very short, spreading out a little at the foot; surface granulated or shagreen-like, with a few small tubercles scattered over it. No trace of divisions can be detected in this part. Above, there are two circles of five plates each, fitting closely together and concealing the arms entirely. The lower plates are pentagonal with rounded corners, the upper and lower sides being parallel. The lower sides do not form a continuous line from plate to plate, so that there are small triangular spaces left between them. There is a row of tubercles on each side of a plate, and one in the middle forming a ridge which projects a little downward over the lower edge of the plate. On the upper edge of these plates are articulated five smaller triangular ones, firmly closed together. They have also a ridge in the middle in continuation of the ridge in the lower plates. The larger pentagonal plates are the radial axillaries of Sir Wyville Thomson, but the smaller triangular ones seem to become fused with them in the adult. Color black. Diameter at base 3 mm., height a little over 1 mm.

PLATE II.

Young Holopus from above and in profile, magnified about eighteen diameters.

CRINOIDS.

Pentacrinus Mülleri Oersted.

Numerous specimens dredged by Captain Sigsbee off Havana in 175 fathoms.

Rhizocrinus lofotensis Sars.

Station No. 17. Lat. 22° 9′ N., Long. 82° 21′ W. 175 fms.
" " 43. Lat. 24° 8′ N., Long. 82° 51′ W. 339 fms.
" " 44. Lat. 25° 33′ N., Long. 84° 35′ W. 539 fms.
" " 29. Lat. 24° 3′ N., Long. 84° 5′ W. 955 fms.

Rhizocrinus Rawsonii Pourt.

(Sigsbee.) Off Havana. 175 fms.

Antedon Hagenii Pourt.

The young are marked with dark brown spots arranged in pairs on the beginning of the arms, but becoming confluent towards the end. In the adult the spots are hardly apparent.

Station No. 32. Lat. 23° 52′ N., Long. 88° 5′ W. 95 fms.
(Sigsbee.) Lat. 22° 9′ N., Long. 82° 21′ W. 177 fms.
" Lat. 22° 9½′ N., Long. 82° 21½′ W. 242 fms.

Antedon meridionalis A. Ag.

This species seems to vary considerably with age, older and larger specimens, of which there are more in this collection than in the former ones, looking so much more massive than the young that they at first sight appear like different species, although the usual specific characters agree.

Station No. 32. Lat. 23° 52′ N., Long. 88° 5′ W. 95 fms.
" " 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.

The range of this species extends from South Carolina to Brazil, the Museum having specimens from various localities from Charleston to Cape Frio. A species common on the coast of Brazil answers to the description of the *Comatula carinata* Lamk. (Leach sp.). It is quoted as from Mauritius, and the Museum has specimens from Zanzibar, differing only in some minor details from the Brazilian ones. I can find no specimens in our collection with the characters of *Antedon Dübeni* Bölsche described as being from Rio Janeiro.

Antedon cubensis Pourt.

To this species I refer provisionally two specimens very much mutilated, having lost the cirrhi and the arms, differing somewhat from my type speci-

men, but possibly the differences may be due to age. The centrodorsal piece is long conical or rather acorn-shaped, 5 mm. high by 3½ in diameter; it has ten vertical rows of horseshoe-shaped sockets for the cirrhi, 5 or 6 to a row, alternate on contiguous rows. It shows in the upper part ridges corresponding to the interambulacral spaces. Cirrhi with long compressed joints. First radials projecting beyond the edge of the centrodorsal piece. Second radials smooth and but little shorter than broad (in the type of my *A. cubensis* the first radials are not visible and the second quite short). Axial rhombic. First brachials well separated from one another. Syzygium in third joint, afterwards four joints between two syzygia. Mouth eccentric; anus central and tubular.

Station No. 43. Lat. 24° 8′ N., Long. 82° 51′ W. 339 fms.

A smaller equally mutilated specimen had been dredged by myself formerly in 450 fathoms near Havana.

Antedon alata Pourt. sp. nov.

Ten to twelve arms. Centrodorsal piece flat and destitute of cirrhi in the centre. The cirrhi in one row, about fifteen in number, with seventeen to eighteen joints, which are rather short, thick and compressed; the fourth joint is the longest. Every joint has a blunt spine on the lower side. First radial concealed, second short; axial short, triangular. First syzygium in third joint; four or five joints between successive syzygia. They increase in size from the beginning to the middle of the arm. The distal edge of the joints is raised in the shape of a serrated scale on the side nearest the pinnule, particularly about the middle of the arm. The first pinnule is longest; they then diminish, to increase again somewhat till near the end of the arm. A membranous expansion borders the arms, embracing three or four joints of the pinnules and fringing the latter also in proportion. This expansion is greatest towards the end of the arm. Mouth eccentric; anus not quite central, prominent, and partly surrounded by calcareous papillæ. Color in alcohol, light, with darker bands across the arm, about six joints apart. Spread about 10 cm.

Barbados. 100 fms. Hassler Expedition.

Antedon granulifera Pourt. sp. nov.

Twenty arms. Centrodorsal piece hemispherical and covered with cirrhi in the young, but becoming bare and flattened in the middle at a later period, showing more or less obsolete traces of the sockets. At the junction with the radials it has five knobs projecting into the interambulacral spaces. Cirrhi in two or more rows, with fifteen to eighteen joints, longer than broad, except the two or three first ones, which are very thick. Penultimate with a spine. First radials entirely concealed, very firmly connected with one another and with the rosette. Second radials thin; axials very depressed, pentagonal. First brachials rather flattened and in close lateral contact. Three brachials between primary and secondary axials, one between secondary and tertiary. Syzygia rather irregular, nine, ten, or more joints apart. Sometimes there are syzygia

in the first and second joints of the arms. The joints are somewhat saddle-shaped, with a deep notch for the insertion of the pinnules and a point on the proximal border fitting into a shallow notch of preceding joint. About the middle of the arm they are frequently, but not always, ornamented with bead-like tubercles, of which the middle one is largest. These tubercles are also found generally on the radials. First pinnule longest and very broad on first brachial, thence diminishing in length towards extremity. The joints of the pinnules are very broad. Mouth central. Spread 20 to 25 cm.

Station No. 45. Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.

Antedon pulchella, Pourt. sp. nov.

Twenty arms. Centrodorsal piece flattened, with rough middle surface destitute of cirrhi. The latter, about thirty in number, in two irregular rows, made up of fifteen to eighteen joints, about as long as broad, except fifth, sixth, and seventh, which are longer; penultimate with spine. First radials and sometimes part of second concealed; the latter rounded on the side and well separated from their neighbors. Axials low, pentagonal. First brachials in contact laterally with one another in the lower part. A syzygial joint in the first and second brachials after the final division of the arms. No syzygium in second axials. A syzygium in the fourteenth or fifteenth joint, and the next one eight joints beyond. Joints smooth, rounded, very oblique, finely crenulate on distal edge. First pinnule longest. Mouth and anus both somewhat eccentric, a few calcareous granules about the latter. Color white.

The principal differences between this and the preceding species are the much shorter cirrhi, rounded and more oblique joints, with very shallow notch for the pinnule; the arms well separated as far down as the first radials, whilst in the other the flattened radials, axials, and first brachials are in close lateral contact.

Label of locality lost.

OPHIURANS AND ASTROPHYTONS.

OPHIURIDÆ.

Ophiopeza Petersi sp. nov.

Plate II. Figs. 22 - 24.

Special Marks. — Radial shields naked. Mouth-shields wider than long.

Description of an Individual. — Diameter of disk 9 mm. Length of arm about 54 mm. Width close to disk, without spines, 1.8 mm. Mouth-papillæ from sixteen to eighteen to each angle, the three outer being wider and rounded; the next three or four tooth-like and sharply pointed; the two at the apex shorter with a rounded edge. Mouth-shields large, triangular, with a blunt angle inward, and outer edge irregularly curved; length to breadth 2 : 2.5 mm. Side mouth-shields very small, triangular, occupying the lateral corners of the mouth-shield. First under arm-plate small, broad hexagonal, with sharp angles at the lateral corners; the rest are about as long as wide, and rounded, with the outer edges overlapping, and having re-entering curves on the lateral sides, where are the tentacle-scales. Side arm-plates flat, meeting neither above nor below, the entire length of the arm. Upper arm-plates slightly swollen, wider without than within, having straight lateral sides and the outer side curved. Radial shields small, widely separated, longer than broad; length to breadth 1.5 : .7. The rest of the disk above and below, as also the space between the mouth-shield and tooth-papillæ, is covered closely with fine grains, about eighteen to the length of a mm. Five or six short, blunt, tapering arm-spines, evenly spaced on the outer edge of side arm-plate; the four uppermost about .7 mm. long, the lowest 1 mm. Toward tip of arm there are only three spines. Two flat rounded tentacle-scales to each pore, whereof the upper one covers the base of the lowest arm-spine. Color in alcohol, pale yellow.

Sigsbee, Lat. 22° 9′ 15″ N., Long. 82° 21′ W., 177 fathoms, 3 specimens.

O. Petersi differs from *O. fallax* in having naked radial-shields, a coarser granulation, fewer arm-spines, and wider mouth-shields; and from *O. Yoldii* in having radial shields and the lowest arm-spine longest, while *O. Yoldii* has the middle one longest. The genus stands so close to *Pectinura* as scarcely to be separable.

Ophioglypha variabilis Lym.

Ophioglypha variabilis, Bull. Mus. Comp. Zoöl. Vol. V. No. 7, p. 85, Pl. III. Figs. 70, 78, 79. 1878.

Station 16, 785 fathoms, 1 specimen (Var. ?). Station 29, 955 fathoms, 1 specimen. Station 41, 860 fathoms, 1 specimen.

I am not able to certainly distinguish these specimens from those of the "Challenger" brought from deep water near Amboyna.

Ophioglypha acervata Lym.

Ophioglypha acervata, Bull. Mus. Comp. Zoöl. Vol. I. No. 10, p. 316. 1869. Ill. Catal. Mus. Comp. Zoöl. No. VI. Pl. I. Fig. 6. 1871.

Station 35, 804 fathoms, 1 specimen. Station 36, 84 fathoms, 3 specimens. Sigsbee, off Havana, 128 – 240 fathoms, 2 specimens (var ?). Sigsbee, off Havana, 119 fathoms, 5 specimens.

Ophioglypha falcifera Lym.

Ophioglypha falcifera, Bull. Mus. Comp. Zoöl. Vol. I. No. 10, p. 319. 1869. Ill. Catal. Mus. Comp. Zoöl. No. VI. Pl. I. Figs. 3, 4.

Station 43, 339 fathoms, 1 specimen. Station 44, 539 fathoms, 1 specimen.

Ophiomastus secundus sp. nov.

Plate II. Figs. 16 - 18.

Special Mark. — One tentacle-scale.

Description of an Individual (Station 43). — Diameter of disk 2.7 mm. Length of arm 5 mm. Width of arm close to disk 1 mm. Mouth-papillæ represented only by a narrow border along the sides of the mouth-frames, with one large and much swollen one at apex of jaw. Mouth-shield somewhat sunken, five-sided, with sharp angle inward. Side mouth-shields large, much swollen, ovoid, longer than broad, meeting broadly within. First under arm-plate nearly triangular ; those beyond are longer than broad, with a blunt angle inward, outer edge rounded, and small re-entering curves on the lateral sides. Side arm-plates very large, much swollen without, meeting broadly below, and above beyond the first upper arm-plate ; wider in the middle, and narrower at the upper and lower ends. Upper arm-plates as broad as long, quadrangular, with broad angle within and a curve without. Disk dome-shape and very high, with a rosette of six large angular primary plates in the centre, and covering nearly the whole upper surface ; outside these are the radial shields, short and wide ; widest without, where they have a curved edge ; closely joined their whole length. Interbrachial space below covered by one or two small triangular scales. One, or more usually two, very short blunt arm-spines, situated midway on the outer edge of the side arm-plate. One tentacle-scale.

Color in alcohol, pale straw.

Station 43, 339 fathoms, 2 specimens.

Ophiomusium planum sp. nov.

Plate III. Figs. 46 - 48.

Special Marks. — Arms even and cylindrical. Upper and under arm-plates persistent nearly to end of arm, but no tentacle-scales beyond the third or fourth under plate. Genital openings bounded by small, close-set papillæ. Disk covered above by large radial shields and small irregular scales, among which the primary plates are scarcely conspicuous. Arm-spines minute.

Description of an Individual (Station 29). — Diameter of disk 18 mm. Width of arm without spines 3.5 mm. Length of arm about 90 mm. Six

short, squarish, close-set mouth-papillæ on each side of an angle, with one spearhead-shaped at the apex. Mouth-shield flat, of a rounded heart-shape, with a small peak within, and a curve without; length to breadth 3 : 2.7 mm. Side mouth-shields small, much wider without than within, where they just meet. First under arm-plate small and rounded; the next three are as wide as long, with outer side curved and much wider than the inner, which is an obtuse angle; lateral sides re-enteringly curved opposite the tentacle-pores. The rudimerary plates beyond have a rounded triangular shape. Side arm-plates large, not swollen, meeting broadly below and above beyond the third upper arm-plate. First two upper arm-plates quadrangular, with inner angle truncated; beyond, they are diamond-shaped. Disk flat and five-sided, covered with large radial shields and thin plates and scales. The central primary plate, which is much smaller than the other five, is separated from them by numerous fine scales. Radial shields long triangular, slightly swollen, minutely tuberculated, having a rounded angle within, and outer edge curved; separated their entire length by irregular rows of minute scales; length to breadth 6.2 : 3. Interbrachial spaces above and below also filled by rows of scales, whereof one larger stands on the margin of the disk. Genital openings reaching about two thirds the distance to the margin, bounded on both edges by ten or more very small, rounded, closely soldered papillæ. Three minute arm-spines. A small tentacle-scale on either side of each pore. Color in alcohol, pale straw.

Station 29, 955 fathoms, 3 specimens.

This species stands next *O. archaster*, from which it is distinguished by the covering of the disk.

Ophiomusium testudo Lym.

Ophiomusium testudo, Ill. Cat. Mus. Comp. Zoöl. Vol. VIII. Pt. II. p. 8, Pl. I. Figs. 6–8. 1875.

Sigsbee, off Havana, 177 fathoms, 3 specimens (var. ?). Sigsbee, off Havana, 80 fathoms, 1 specimen. Station 45, 101 fathoms, 9 specimens.

Ophiomusium validum Ljn.

Ophiomusium validum, Öf. Kong. Akad. Dr. Goës Oph. p. 618. 1871.

Station 2, 800 fathoms, 1 specimen. Station 16, 292 fathoms, 1 specimen. Station 29, 968 fathoms, 9 specimens. Station 33, 1568 fathoms, 1 specimen. Station 41, 860 fathoms, 1 specimen.

These are identified by the original sent me from Stockholm through the courtesy of Prof. Lovén.

Ophiomusium acuferum Lym.

Ophiomusium acuferum, Ill. Catal. Mus. Comp. Zoöl. No. 8. Pt. II. p. 7, Pl. I. Figs. 1–5. 1875.

Station 20, 220 fathoms, 1 specimen. Station 32, 95 fathoms, 5 specimens.

Station 36, 84 fathoms, 5 specimens. Sigsbee, off Havana, 80 fathoms, 1 specimen. Sigsbee, off Havana, 175 fathoms, 2 specimens. Sigsbee, Lat. 26° 31′ N., Long. 85° 3′ W., 119 fathoms, 2 specimens. Sigsbee, off Havana, 127 fathoms, 1 specimen.

Ophiomusium serratum Lym.

Ophiomusium serratum, Bull. Mus. Comp. Zoöl. Vol. V. No. 7, Pt. I. p. 109, Pl. I. Figs. 23 – 25. 1878.

Sigsbee, off Havana, 480 fathoms, 1 specimen (var. ?). Sigsbee, off Havana, 242 – 450 fathoms, 5 specimens.

Ophiomusium eburneum Lym.

Ophiomusium eburneum, Bull. Mus. Comp. Zoöl. Vol. I. No. 10, p. 322. 1869. Ill. Catal. Mus. Comp. Zoöl. No. VI. Pl. II. Figs. 1 – 3. 1871.

Sigsbee, off Havana, 175 fathoms, 2 specimens. Sigsbee, off Havana, 127 fathoms, 1 specimen (var. ?). Station 20, 220 fathoms, 1 specimen.

OPHIOLIPUS * gen. nov.

Entire animal covered with a thick, smooth skin, which more or less obscures the underlying plates. Mouth-papillæ; teeth; no tooth-papillæ. Tentacle-pores only at the basal under arm-plates; beyond these there are none. Upper arm-plates rudimentary and scarcely calcified. Two genital openings in each interbrachial space.

Despite its thick, uncalcified skin, this genus stands very near *Ophiomusium*, from which, however, it is further separated by the rudimentary upper arm-plates, which consist only of thin disconnected, irregular fragments.

Ophiolipus Agassizii sp. nov.

Plate III. Figs. 52 - 54.

Special Marks. — Tentacle-pores only at the second and third under arm-plates. Genital openings bounded on either side by a close row of angular granules. No arm-spines except at the tip of arm, where there are two minute ones.

Description of an Individual (Station 49). — Diameter of disk 18 mm. Length of arm 75 mm. Width of arm 4.5 mm. Five large, close-set, irregularly rounded mouth-papillæ on each side, the two outer ones largest; and three more pointed at apex of the jaw. Five or six spiniform teeth, irregularly set, and of unequal size. Mouth-shields small, longer than broad, with a rounded angle inward, outer edge rounded, and slight lobes on the lateral corners; length to breadth 2 : 1.5 mm. Side mouth-shields much obscured by the thick skin, narrow within, where they nearly or quite meet, broader without, and extending to the genital opening. First under arm-plate very small, rounded quadrangular; the next two are large, much wider without than within, and

* Ὄφις, snake; λίπος, grease.

have re-entering curves on their lateral sides, where are the tentacle-pores; beyond these, they are broad, triangular, with the two inner sides curved. Side arm-plates thick and smooth, meeting below, beyond the third under arm-plate, separated above by the large, triangular upper arm-plates, which are obscured by the thick skin, but, on drying, are seen to be cracked in many irregular pieces. Disk thin, with constrictions between the arms, covered with a thick skin which obscures the thin, irregular, angular scaling, to be seen only when partly dry; on the margin of the interbrachial space there is a semicircular plate. Radial shields large, longer than broad, of an angular oval shape, widely separated by the disk-scaling; length to breadth 5 : 4. Genital opening extending from the mouth-shield about two thirds of the way to the margin, and bordered on either side by a close-set row of angular granules. Two small, flat, rounded tentacle-scales on the interbrachial side of the tentacle-pores of the second and third under arm-plates; those of the second being the larger. No arm-spines, except at tip of arms, where there are two, low down, and like minute papillæ. Color in alcohol, pale yellow.

Station 49, 118 fathoms, 12 + specimens.

This curious species is of a brilliant orange-color when alive. It was brought up in large numbers from a bottom of soft mud. At the first glance it seems an *Ophiomyxa*, but, when partly dry, the details of external structure appear.

Ophioconis miliaria sp. nov.

Plate III. Figs. 49-51.

Special Marks. — Seven or eight arm-spines, the upper ones as long as three arm-joints. Two tentacle-scales.

Description of an Individual (off Havana). — Diameter of disk 7.5 mm. Length of arm about 35 mm. Width of arm close to disk, without spines, 2.3 mm. There are ten or more short, pointed, close-set papillæ on each side of the mouth-angle, the four outer ones and that at apex of jaw being larger and more rounded. On removing the fine granulation which closely covers the mouth-angle, the mouth-shield can be seen, of a rounded heart-shape, with a sharp angle within. Side mouth-shields small, long and narrow, not quite meeting within. Under arm-plates overlapping, wider without than within, with outer edge curved, and deep re-entering curves on the lateral sides, where are the tentacle-scales. Side arm-plates small and thin, meeting neither above nor below. Upper arm-plates rounded, transverse diamond-shaped, with an obtuse angle within, and outer edge irregularly curved; they are highly arched, forming a longitudinal ridge. Disk round and flat, covered above and below with a close, fine granulation, about 13 grains in the length of a mm. No radial shields to be distinguished beneath the granulation. Genital openings short, extending from the mouth-shield only about half-way to the margin of the disk. Arm-spines near disk seven or eight, long and slender, the three upper ones being about as long as three arm-joints, the four or five lower considerably shorter. Two short, flat, bluntly pointed tentacle-scales, of which

the upper one partly overlaps the base of the lowest arm-spine. Color in alcohol, pale yellow.

Sigsbee, off Havana, 243 – 450 fathoms, 1 specimen.

This species differs from *O. Forbesii* in the greater number and length of the arm-spines, and in having two tentacle-scales.

Ophiochœta (?) mixta sp. nov.

Plate II. Figs. 40 - 42.

Special Marks. — Disk closely beset with grains, among which, on the upper surface, appear numerous short spikes. Seven arm-spines; the two upper ones longest, and as long as three arm-joints.

Description of an Individual. — Diameter of disk 8 mm. Length of arm about 60 mm. Width of arm without spines 2.3 mm. To each mouth-angle there are fourteen papillæ; the three outer being stoutest and flattened, the rest spine-like, with the smallest at the apex. Six short, wide, flat teeth. Mouth-shields large, triangular, with a blunt angle within, and outer edge curved; length to breadth 1.3 : 1.3. The space between the mouth-shield and the mouth-papillæ is covered with minute grains, similar to those of the disk. Under arm-plates broader than long, much broader without than within; outer side curved; lateral sides re-enteringly curved. The first plate is small, of a transverse oval shape, with lateral corners pointed. Side arm-plates narrow, slightly projecting at their outer edge, meeting below midway on the arm, but separated above by the somewhat swollen upper arm-plates, which are rudely hexagonal, with their inner lateral sides longest Disk flat, pentagonal, densely covered with small, rounded grains, interspersed above with short spikes of varying length. On removing this granulation, the radial shields are seen to be longer than wide, but quite small, and separated their entire length. Seven long, tapering arm-spines, the five lower being equal, and about as long as two arm-joints, while the two upper are longer. Two large, angular tentacle-scales, whereof the upper one overlaps the base of the lowest arm-spine. Genital opening long and narrow, the scale being quite covered by granulation. Color in alcohol, disk pale olive-green, arms lighter.

Sigsbee, off Havana, 242 fathoms, 4 specimens. Sigsbee, off Havana, 160 fathoms, 5 specimens. Sigsbee, off Havana, 175 fathoms, 5 specimens.

In the long and more movable arm-spines (not standing on the extreme outer edge of the side arm-plate, nor clinging to the arm) and the differently shaped under arm-plates, this species varies from *Ophiochœta* as defined by Lütken (Addit. ad Hist. Oph. III. pp. 38, 89, 98, 105); nevertheless, it may perhaps be placed in that genus without impropriety.

Ophiothyreus Goësii Ljn.

Ophiothyreus Goësii, Öf. Kong. Akad. Dr. Goës Oph. p. 619. 1871.

Sigsbee, off Havana, 80 fathoms, 1 specimen. Sigsbee, off Havana, 127 fathoms, 8 specimens. Sigsbee, off Havana, 175 fathoms, 2 specimens. Sigsbee, off Havana, 242 fathoms, 2 specimens.

Ophiochondrus convolutus Lym.

Ophiochondrus convolutus, Bull. Mus. Comp. Zoöl. Vol. I. No. 10, p. 328. 1869. Ill. Catal. Mus. Comp. Zoöl. VI. Pl. II. Fig. 7.

Station 16, 292 fathoms, 2 specimens. Sigsbee, off Havana, 175 fathoms, 1 specimen.

Ophiozona tessellata sp. nov.

Plate III. Figs. 43-45.

Special Marks. — Three spaced arm-spines, about two thirds as long as an arm-joint. Two large tentacle-scales, side by side. A small thick spine or spike outside each radial shield.

Description of an Individual (Station 11). — Diameter of disk 8 mm. Length of arm about 35 mm. Width of arm without spines 1.5 mm. Eleven short, close-set, rounded papillæ to each mouth-angle, those within being smaller and more pointed. Mouth-shields longer than broad, and wider within than without, small, hexagonal, with a blunt angle inward, outer side rounded, and slightly re-entering curves on the lateral sides ; length to breadth 1.2 : 1. Side mouth-shields small, much curved, slightly swollen, longer than wide, with rounded ends inward, where they just meet. Under arm-plates four-sided, much wider without than within ; having the outer side curved and lateral sides re-enteringly curved. Side arm-plates small and lowest at their outer edge, meeting neither below nor above, where they are separated by smooth, slightly swollen, quadrangular upper arm-plates, having a curved outer edge wider than the inner one. Disk thin and round, covered with small, somewhat swollen plates, whereof six primaries in a central rosette are conspicuous by their larger size ; in each interbrachial space there is a radiating row of three differently shaped plates. Radial shields of a rude egg-shape, with the small end inward ; separated their whole length by a single row of plates, whereof the innermost is nearly as large as a primary. On the outer edge of each radial shield are two narrow plates, on which stands a short, blunt, rounded spine. Genital opening extending nearly to margin of disk ; the rest of the lower interbrachial space outside the mouth-shield is occupied by small irregularly shaped plates. Three short tapering arm-spines, evenly spaced on the outer edge of the side arm-plate, and about two thirds as long as an arm-joint. Two flat rounded tentacle-scales on the inner edge of each tentacle-pore. Color in alcohol, pale straw.

Station 11, 242 fathoms, 1 specimen.

This species stands near *O. insularia* (Bull. Mus. Comp. Zoöl. V. No. 7, p. 127), but is readily distinguished by its two large tentacle-scales and different under arm-plates, and by the little spine outside the radial shield.

Ophiozona nivea Lym.

Ophiozona nivea, Ill. Catal. Mus. Comp. Zoöl. No. VIII. Pt. II. p. 9, Figs. 85, 86. 1875.

Station 16, 292 fathoms, 1 specimen. Station 21, 287 fathoms, 3 specimens. Sigsbee, off Havana, 177 fathoms, 1 specimen. Sigsbee, off Havana, 242 fathoms, 2 specimens.

Ophiozona (?) dubia sp. nov.

Plate II. Figs. 19-21.

Special Marks. — Two or three small arm-spines. First pair of side arm-plates very large, and meeting outside the mouth-shield.

Description of an Individual (Station 44). — Diameter of disk 3.5 mm. Length of arm 6.5 mm. Width of same without spines .8 mm. There are about ten short, rounded, bead-like mouth-papillæ, closely set, with one or two at the apex lying below the teeth, which are large and spearhead-shaped. Mouth-shield small, rounded diamond-shape. Side mouth-shields short, rather wide, and meeting within. Under arm-plates small, shield-shape, with an angle inward; longer than broad, with very deep re-entering curves on the lateral sides, so that those towards the end of the arm have but a thin partition between the tentacle-pores. Side arm-plates large, swollen without, meeting broadly above and below, so as to form almost the entire covering of the arm. The first pair are of great size, and meet just outside the mouth-shield, covering nearly the entire lower interbrachial space. Upper arm-plates very small, long diamond-shaped, with the sharp angle inward. Disk five-sided and somewhat swollen, covered with thin, broken, ill-defined, angular plates. Radial shields longer than broad, rudely oval, nearly or quite meeting without, diverging widely within; wedged between their outer points is a diamond-shaped scale. In the interbrachial space there is one large angular marginal plate. Two or three short, blunt, tapering arm-spines situated midway on the outer edge of the side arm-plates. One round tentacle-scale on the inner edge of the tentacle-pore. Color in alcohol, white. Station 44, 539 fathoms, 1 specimen.

The great size of the first pair of side arm-plates and the want of definition in the disk-plates seem to make the position of this species in *Ophiozona* doubtful, but I think it best to wait for larger specimens before settling definitely its position.

Ophiostigma isacanthum Lym.

Ophiura isacantha Say, Journ. Phil. Acad. V. p. 150. 1825.
Ophiostigma moniliforme Ltk., Addit. Ad. Hist. Oph. p. 132.
Ophiostigma isacanthum, Ill. Catal. Mus. Comp. Zoöl. p. 103, Figs. 8, 9. 1865.

Station 10, 37 fathoms, 3 specimens. Station 12, 36 fathoms, 1 specimen. Station 39, 14 fathoms, 1 specimen.

Ophiactis Mülleri Ltk.

Ophiactis Mülleri, Vid. Meddel. Jan. 1856. p. 12.

Key West, Fla., 12 + specimens. Station 11, 37 fathoms, 12 + specimens, var. *quinqueradia.*

Ophionereis reticulata Ltk.

Ophiura reticulata Say, Journ. Phil. Acad. V. p. 148. 1825.
Ophionereis reticulata, Addit. ad Hist. Oph. Pt. II. p. 110. 1859.

Station 11, 37 fathoms, 1 specimen.

Amphiura tumida sp. nov.

Plate II. Figs. 28 - 30.

Special Marks. — Ten mouth-papillæ to each angle, whereof eight are small and bead-like, and two, under the teeth, are very large and swollen.

Description of an Individual (Station 47). — Diameter of disk 9.5 mm. Width of arm without spines 1 mm. Arms very long, but broken, so that measurement was impossible. Four short bead-like mouth-papillæ on either side of the mouth-angle, and two large and much swollen at the apex; those on the sides form a re-entering curve. Mouth-shield large, angular egg-shape, with the rounded edge outward. Side mouth-shields small, narrow, and just meeting within, with outer end club-shaped. Under arm-plates large, pentagonal, with inner angle more or less truncated or rounded, lateral sides re-enteringly curved, and outer edge curved; at some distance out on the arm the inner angle is sharp. Side arm-plates flat, and projecting at their outer edge, meeting neither above nor below. Upper arm-plates broad and rounded, much wider without than within, and showing the underlying ridge of the arm-bone. Disk puffed, and lobed in the interbrachial spaces. Upper surface covered with very thin, flat, overlapping, semicircular scales, about seven in the length of a mm., where they are coarsest. Radial shields long, curved, and very narrow, a little wider without, tapering inward, widely separated, except at their outer points, by fine scaling; just outside their tips is a minute crotchet. Interbrachial spaces on the under surface also covered by fine scales. Genital scales long, narrow, and hidden, except at their outer end. Three or four pointed arm-spines, about as long as a joint, and placed close together. Two small, flat, rounded tentacle-scales, one on the brachial side of the tentacle-pore, the other on the side arm-plate. Color in alcohol, pale yellow, spotted with reddish.

Station 47, 321 fathoms, 2 specimens.

Amphiura cuneata sp. nov.

Plate II. Figs. 34 - 36.

Special Marks. — Ten similar bead-like mouth-papillæ to each angle. Three slender arm-spines.

Description of an Individual (Station 43). — Diameter of disk 3 mm. Width of arm without spines .7 mm. Ten minute bead-like mouth-papillæ to each mouth-angle, whereof two are at the apex. Mouth-shields small, longer than wide, with a sharp angle within, lateral sides curved, and outer edge rounded. Side mouth-shields long, wedge-shaped, rounded, and slightly swollen without, tapering inward, where they just meet. Under arm-plates pentagonal, with an angle inward, and lateral sides a little re-enteringly curved. Side arm-plates small and narrow, meeting below beyond the disk, but separated above by the somewhat arched upper arm-plates, which are rounded, with a curve without and within. Disk rather flat, covered above and below with small, thin, overlapping scales. Radial shields long and narrow, with the outer ends touching and swollen, separated slightly within by a wedge of minute scales. Three slender arm-spines, bluntly pointed, about as long as an arm-joint, evenly

spaced on the side arm-plate. Two minute, short, rounded tentacle-scales on the inner side of the tentacle-pores. Color in alcohol, pale brown.

Station 43, 339 fathoms, 2 specimens.

Amphiura lunaris sp. nov.

Plate II. Figs. 31-33.

Special Marks. — Disk-scales swollen. Three arm-spines. One or two minute mouth-papillæ at outer corner of mouth-slit and two at apex of jaw.

Description of an Individual (Station 29). Diameter of disk 4 mm. Length of arm 17 mm. Width of arm close to disk .7 mm. One (sometimes two) small, rounded, scale-like mouth-papillæ on either side, near juncture of first under arm-plate and side mouth-shields, with two a little larger at the apex of jaw. Above may be seen the long sçale of the first mouth-tentacle. Mouth-shields small, broader than long, with sharp angles at the lateral corners, outer edge rounded, and an angle within. Side mouth-shields longer than broad, wider without than within, where they just meet. Under arm-plates longer than wide, pentagonal, with a well-marked angle inward ; midway out on the arm the plates become long, triangular, with an angle inward. Side arm-plates large and flaring, barely meeting below and above near base of arm. Upper arm-plates swollen, of a transverse oval shape. Disk round and flat, covered with small, swollen, overlapping scales ; those in the centre being a little the largest. Radial shields flat pear-seed shape, with the peak inward, just touching without, separated within by a wedge of two or three minute scales. On the under surface the interbrachial space is covered with much finer scaling than that above. Genital slits long, extending from the outer corner of the mouth-shield to margin. Three short, stout, tapering, pointed arm-spines, the upper and under being often a little shorter than the middle one. One minute flat tentacle-scale on the inner side of the pore. Color in alcohol, white.

Station 29, 955 fathoms, 2 specimens.

Amphiura duplicata Lym.

Amphiura duplicata, Ill. Catal. Mus. Comp. Zoöl. No. VIII. Pt. II. p. 19, Pl. V. Fig. 78.

Station 2, 800 fathoms, 1 specimen (young, var.). Station 17, 320 fathoms, 1 specimen. Station 19, 310 fathoms, 2 specimens. Station 20, 220 fathoms, 1 specimen. Station 33, 1568 fathoms, 2 specimens. Station 44, 539 fathoms, 1 specimen.

Some specimens show a certain amount of variation ; especially the division of the first under arm-plate is sometimes not distinct, and perhaps does not exist.

Amphiura grandisquama Lym.

Amphiura grandisquama, Bull. Mus. Comp. Zoöl. Vol. I. No. 10, p. 334. 1869.

Station 5, 152 – 229 fathoms, 2 specimens.

Amphiura semiermis Lym.

Amphiura semiermis, Bull. Mus. Comp. Zoöl. Vol. I. No. 10, p. 332. 1869.

Station 44, 539 fathoms, 4 specimens.

Ophiocnida abnormis sp. nov.

Plate II. Figs. 37-39.

Special Marks. — A wide mouth-papilla, occupying nearly the whole length of the mouth-frame, on either side, with a group of four tooth-like papillæ at the apex.

Description of an Individual (Station 45). — Diameter of disk 4 mm. Length of arm about 40 mm. Width of arm without spines 1 mm. A very wide mouth-papilla on either side, occupying nearly the whole length of the angle, and a group of four tooth-like papillæ at the apex. Mouth-shield wide heart-shape, with the angle inward. Side mouth-shields short and wide, somewhat swollen, broader without, tapering inward, where they nearly or quite meet. Under arm-plates pentagonal, broader than long, with inner angle more or less truncated, and outer edge gently curved. Side arm-plates small, slightly flaring without, and just meeting below; separated above by the upper arm-plates, which are broad fan-shape, with an angle inward. Disk thin, slightly puffed, covered above and below with small overlapping scales, and beset above with a few blunt spines. Radial shields long, pear-seed shape, touching without, separated within by a wedge of scales. Three short, stout, blunt, tapering arm-spines placed close together. Two minute tentacle-scales on the basal joints; only one beyond. Color in alcohol, pale straw.

Station 45, 101 fathoms, 1 specimen.

Ophiocnida olivacea Lym.

Ophiocnida olivacea, Bull. Mus. Comp. Zoöl. Vol. I. No. 10, p. 340. 1869. Ill. Catal. Mus. Comp. Zoöl. VI. Pl. I. Figs. 7, 8.

Sigsbee, off Havana, 119 fathoms, 1 specimen.

Ophiopsila fulva sp. nov.

Plate II. Figs. 25-27.

Special Marks. — Six or eight sharp mouth-papillæ to each angle. Long, very narrow, separated radial shields. Ten or twelve flattened arm-spines.

Description of an Individual (off Havana). — Diameter of disk 7.5 mm. Width of arm without spines 1.8 mm. There are two or three long, flat, tapering mouth-papillæ on either side of the mouth-angle, with two or three shorter ones at the apex of jaw. Mouth-shield occupying almost the whole mouth-angle, broad, swollen, heart-shaped, with a wide angle within. Side mouth-shields rudimentary, situated close to the outer corners. Under arm-plates narrow, four-sided, slightly swollen on the inner margin, lateral sides straight, and a small notch on the outer edge. Side arm-plates curved on their outer edge, meeting neither above nor below. Upper arm-plates very small, longer than wide, and rounded. Disk slightly puffed and wrinkled, with

small lobes in the interbrachial spaces; covered above and below with minute overlapping scales. Radial shields long, curved, and very narrow, a little wider without, but tapering inward, separated their entire length. Genital openings long, extending from the mouth-shield to the margin of disk. Ten or twelve flattened, smooth, bluntly pointed arm-spines, as long as a joint, arranged in a close line along the outer edge of the side arm-plate; those above and below longer than the three middle ones. Tentacle-scales blunt dagger-shaped, and similar to arm-spines, but smaller. Color in alcohol, pale gray, mottled with reddish-brown.

Sigsbee, off Havana, 175 fathoms, 1 specimen.

Ophiopsila Riisei Ltk.

Ophiopsila Riisei, Addit. ad Hist. Oph. Pt. II. p. 136. 1869.

Station 11, 37 fathoms, 1 specimen. Key West, Fla., 3 specimens.

Ophioplax Ljungmani Lym.

Ophioplax Ljungmani, Ill. Catal. Mus. Comp. Zoöl. No. VIII. Pt. II. p. 22, Pl. II. Figs. 24, 25. 1875.

Station 45, 101 fathoms, 12 + specimens. Sigsbee, off Havana, 127 fathoms, 1 specimen. Sigsbee, off Havana, 80 fathoms, 1 specimen.

Ophiopæpale Goësiana Ljn.

Ophiopæpale Goësiana, Öf. Kong. Akad. Dr. Goës Oph. p. 615. 1871.

Station 45, 101 fathoms, 1 specimen. Sigsbee, off Havana, 80 fathoms, 2 specimens. Sigsbee, off Havana, 177 fathoms, 1 specimen. Sigsbee, off Havana, 242 fathoms, 1 specimen. Sigsbee, off Havana, 127 fathoms, 3 specimens.

Ophiomyces frutectosus Lym.

Ophiomyces frutectosus, Bull. Mus. Comp. Zoöl. I. No. 10, p. 345. 1869.

Sigsbee, off Havana, 119 fathoms, 6 specimens.

Ophiacantha aspera sp. nov.

Plate I. Figs. 10-12.

Special Marks. — Disk closely set with fine stumps, many of them forked. One large flat tentacle-scale, bearing long thorns, which give it a palmated look. Nine or ten slender, thorny, translucent arm-spines.

Description of an Individual (off Havana). — Diameter of disk 5 mm. Width of arm close to disk, without spines, 1.8 mm. Seven round pointed mouth-papillæ to each angle, the one at the apex being a little larger; the outer one is sometimes flattened, with a toothed end. Mouth-shields small, slightly swollen, triangular, with a sharp angle within, and the outer edge much rounded; length to breadth .7 : .7. Side mouth-shields large, short, and broad, nearly semicircular, with curved edge outward, just touching within. Under arm-plates small shield-shaped, wider without than within, where they present an obtuse angle; lateral sides re-enteringly curved. Side arm-plates large, with

a high spine-ridge, meeting above and below. Upper arm-plates small, broader than long, fan-shaped, with an angle inward. Disk round and high, covered above and below with very minute stumps, which often are forked, and which conceal the scaling of the disk. Radial shields long and narrow, concealed by the disk-stumps, except their outer tips. Genital openings large, extending to margin of disk. Nine or ten long, slender, thorny, translucent arm-spines, whereof the highest and largest nearly meet on the upper surface of arm, and are as long as three or four arm-joints. One large flat tentacle-scale, bearing long thorns, which give it a palmated look. Color in alcohol, straw.

Sigsbee, off Havana, 175 fathoms, 6 specimens.

Ophiacantha scutata sp. nov.

Plate I. Figs. 1-3.

Special Marks. — Disk above evenly set with small cylindrical stumps having thorny ends. Long, narrow, separated radial shields. Nine slender, slightly thorny arm-spines. Seven pointed, widely spaced mouth-papillæ.

Description of an Individual. — Diameter of disk 10 mm. Width of arm without spines 2.3 mm. Seven long, rounded, tapering, pointed mouth-papillæ to each angle, the one at the apex being largest. Mouth-shield broader than long, with a wide angle within, and a curve without. Side mouth-shields wide without and narrow within, where they nearly or quite meet. Under arm-plates shield-shaped, outer side strongly curved and much wider than the inner, which makes an obtuse angle ; laterals re-enteringly curved ; the first plate is unusually large. Side arm-plates large and swollen, meeting narrowly above and below. Upper arm-plates triangular, much swollen, having a rounded edge without and an obtuse angle inward ; when dry, they show two longitudinal cracks. Disk round and high, covered with minute cylindrical stumps with thorny ends. Radial shields long, narrow, of nearly equal width, with straight sides, and widely separated. Lower interbrachial space covered with thin, smooth, rounded, overlapping scales, carrying few or no stumps. Genital openings large and long, having a small, narrow scale, which is wider without than within. Eight or nine stout, thorny arm-spines, the three upper ones longest, and about as long as four arm-joints. One long, stout, pointed tentacle-scale on the inner edge of tentacle-pore; the first pore has two. Color in alcohol, pale straw, but bright brick-red when living.

Station 16, 292 fathoms, 1 specimen. Station 21, 287 fathoms, 1 specimen.

Ophiacantha echinulata sp. nov.

Plate I. Figs. 7-9.

Special Marks. — Disk closely set with fine spines. Beyond the first pore, one long, sharp, dagger-shaped tentacle-scale. Nine long, very slender, glassy, thorny arm-spines.

Description of an Individual (Station 29). Diameter of disk 6 mm. Length of arm 40 mm. Width of arm close to disk, without spines, 1.5 mm. Eleven

to fourteen stout, more or less spiniform mouth-papillæ to each angle, whereof the outer are longer; at the apex of jaw are one or two papillæ which are largest of all. Mouth-shield much broader than long, with an obtuse, rounded angle within, outer edge slightly lobed, and lateral sides curved; length to breadth .7 : 1.5 mm. Side mouth-shields long, oval, stout, meeting within, the outer edge being broadly connected with the first under arm-plate, which is larger than usual, with a small lobe without. Those beyond are shield-shaped, longer than broad, wider without than within, where they present an obtuse angle; while the outer side is strongly curved, and the laterals re-enteringly curved, and outer edge, which is wider than inner, gently curved. Side arm-plates large, with a prominent spine-ridge, meeting fully above and below. Upper arm-plates small, of a transverse diamond-shape, with outer and inner angles more or less rounded. Disk flat and thin, covered with delicate spines, which obscure the scaling. Radial shields small and wide, joined their entire length, with a rounded angle inward, and lateral edges nearly straight. Nine very slender, glassy, long, gently tapering, thorny arm-spines, the upper one longest and equal to three arm-joints. Tentacle-scales long, sharp, dagger-shaped, and situated on the inner edge of the tentacle-pore. Color in alcohol, straw.

Station 29, 955 fathoms, 1 specimen.

Ophiacantha Troscheli Lym.

Ophiacantha Troscheli, Bull. Mus. Comp. Zoöl. Vol. V. No. 7, p. 142, Pl. IX. Figs. 223, 224. 1878.

Station 45, 101 fathoms, 3 specimens.

Ophiacantha vepratica Lym.

Ophiacantha vepratica, Bull. Mus. Comp. Zoöl. Vol. V. No. 7, p. 137, Pl. X. Figs. 245 – 247. 1878.

Station 41, 860 fathoms, 2 specimens.

I am unable to see any reliable specific difference between these specimens and those got by the "Challenger" in 600 fathoms near the Fiji Islands.

Ophiacantha pentacrinus Ltk.

Ophiacantha pentacrinus, Addit. ad Hist. Oph. Pl. III. pp. 46, 99. 1869.
Ophiacantha meridionalis Lym., Bull. Mus. Comp. Zoöl. Vol. I. N. p. 324. 1869.

Station 43, 339 fathoms, 9 specimens. Station 44, 539 fathoms, 1 specimen. Sigsbee, off Havana, 175 fathoms, 1 specimen.

Ophiacantha hirsuta Lym.

Ophiacantha hirsuta, Ill. Catal. Mus. Comp. Zoöl. VIII. Pt. II. p. 12, Pl. II. Figs. 21 – 23. 1875.

Sigsbee, off Havana, 175 fathoms, 1 specimen. Sigsbee, off Havana, 127 fathoms, 3 specimens.

Ophiomitra exigua sp. nov.

Plate I. Figs. 4-6.

Special Marks. — Six short, blunt, not thorny arm-spines. Upper surface of disk nearly covered by large naked radial shields, and sparsely set with thick, club-headed, thorny stumps.

Description of an Individual (off Havana). — Diameter of disk 2.5 mm. Length of arm about 18 mm. Width of arm close to disk, without spines, 7 mm. Three short, pointed, tooth-like mouth-papillæ on each side of an angle, with one larger and diamond-shaped at the apex. Mouth-shields very small, triangular, with an angle inward and outer side rounded. Side mouth-shields very large, wide, and swollen, longer than broad, meeting within. Under arm-plates small, pentagonal, with an obtuse angle within, and wide outer edge much rounded, and with re-entering curves on the lateral sides. Side arm-plates large, flaring without, meeting broadly below, but only touching above. Upper arm-plates small, somewhat swollen, fan-shaped, with the angle inward. Disk constricted in the interbrachial spaces and irregularly puffed ; almost the entire upper surface is occupied by the large triangular, swollen, naked radial shields, which are joined their entire length. In the centre is a small patch of irregular scales with five radiating, single, interbrachial rows, and others along the margin. Scattered irregularly are very stout, club-shaped stumps with a crown of strong thorns. Six short, blunt, tapering, not thorny arm-spines, evenly spaced along the spine ridge ; the upper one is the longest. One flat, rounded tentacle-scale. Color in alcohol, blue-gray.

Sigsbee, off Havana, 240 fathoms, 1 specimen.

Ophiomitra chelys Lym.

Ophiacantha chelys Wyv. Thom., Voyage of the "Challenger," The Atlantic, Vol. II. p. 64, Figs. 16, 17. 1877.

Ophiomitra chelys, Bull. Mus. Comp. Zoöl. Vol. V. No. 7, p. 153, Pl. IX. Figs. 239-241. 1878.

Station 2, 800 + fathoms, 2 specimens. Station 15, 785 fathoms, 1 specimen (young, var.). Station 41, 860 fathoms, 2 specimens. Sigsbee, off Havana, 480 fathoms, 2 specimens (young, var.).

Most of the specimens presented variations from the type, especially in having the radial shields nearly level with the disk instead of sunken. See Bull. Mus. Comp. Zoöl. *loc. cit.*

Ophiomitra cervicornis Lym.

Ophiomitra cervicornis, Ill. Catal. Mus. Comp. Zoöl. No. VIII. Pt. II. p. 14, Pl. II. Figs. 19, 20.

Sigsbee, off Havana, 175 fathoms, 4 specimens. Sigsbee, off Havana, 242 fathoms, 1 specimen.

Ophiomitra sertata Lym.

Ophiomitra sertata, Bull. Comp. Zoöl. I. No. 10, p. 326. 1869.

Sigsbee, off Havana, 175 fathoms, 1 specimen.

Ophiothamnus vicarius Lym.

Ophiothamnus vicarius, Bull. Mus. Comp. Zoöl. I. No. 10, p. 342. 1869. Ill. Catal. Mus. Comp. Zöol. No. VI. Pl. II. Figs. 8, 9.

Station 5, 152 – 229 fathoms, 5 specimens. Station 45, 101 fathoms, 1 specimen.

Ophiocamax histrix sp. nov.

Plate I. Figs. 13 - 15.

Special Marks. — Mouth-papillæ numerous and spine-like. Disk covered with rather large and very irregular plates, and radial shields sparsely beset with stout thorny spikes.

Description of an Individual. — Diameter of disk 11 mm. Width of arm close to disk, without spines, 3.5 mm. About thirty long, spiniform, equal mouth-papillæ to each angle, arranged in clusters. Mouth-shields small, slightly swollen, with a long lobe projecting towards the interbrachial space, a blunt angle inward, and lateral corners rounded ; on the outer portion are a few grains. Side mouth-shields very large, meeting broadly within, and connected with the first under arm-plate. Under arm-plates much broader than long, with an obtuse angle within, outer edge slightly curved, and truncated angles on the lateral sides. Side arm-plates large, and projecting, nearly meeting below at base of arm, but not above. Upper arm-plates large, slightly swollen, with the outer edge, which is much broader than the inner, irregularly curved. Disk thick and somewhat swollen, with deep constrictions on the interbrachial spaces, covered with coarse, angular, irregularly shaped plates, carrying a few short, pointed, thorny spikes. Radial shields large, and irregularly angular, wider without than within, where they are separated by one or more wedge-like scales ; length to breadth 3.5 : 2.5 mm. Eight long, thorny, glassy arm-spines, the uppermost being as long as six arm-joints, and the second as four, whence they diminish rapidly downward to the lowest, which is scarcely as long as a joint. Three long, stout, bluntly pointed, thorny tentacle-scales to each pore. Color in alcohol, pale bluish-gray.

Sigsbee, off Havana, 175 fathoms, 7 specimens.

Ophiothrix violacea Müll & Tr.

Ophiothrix violacea Syst., Asterid. p. 115. 1842.
Ophiothrix caribæa Ltk., Vidensk. Meddelelser, Jan. 1856.
Ophiothrix Kroyeri Ltk., Vidensk. Meddelelser, Jan. 1856.

Station 11, 37 fathoms, 8 specimens. Station 12, 36 fathoms, 3 specimens. Station 32, 95 fathoms, 1 specimen. Station 38, 20 fathoms, 2 specimens. Station 39, 14 fathoms, 10 specimens. Station 45, 101 fathoms, 1 specimen. Bahia Honda, 2 specimens.

Ophiothrix Suensonii Ltk.

Ophiothrix Suensonii, Vid. Medd. p. 16. 1856.

Station 45, 101 fathoms, 1 specimen.

Ophiothrix Örstedii Ltk.

Ophiothrix Örstedii, Vid. Medd. p. 15. 1856.

Key West, Florida, 5 specimens.

Ophiothrix lineata Lym.

Ophiothrix lineata, Proc. Bost. Soc. Nat. Hist. VII. p. 201. 1859.

Off Sand Key, 20 fathoms, 7 specimens.

The single specimen brought by Professor Agassiz more than a quarter of a century ago from Florida remained unique until his son again discovered the species.

Ophiomyxa flaccida Ltk.

Ophiura flaccida Say., Journ. Phil. Acad. V. p. 151. 1825.
Ophiomyxa flaccida, Addit. ad Hist. Oph. Pt. II. p. 138. 1859.

Station 10, 37 fathoms, 8 specimens (young). Station 11, 37 fathoms, 11 specimens. Station 45, 101 fathoms, 1 specimen. Sigsbee, off Havana, 175 fathoms, 6 specimens.

Ophioscolex purpureus Düb. & Kor.

Ophioscolex purpurea, Öf. Kongl. Vet. Akad. p. 235. 1844.

Station 23, 190 fathoms, 2 specimens.

Highly interesting as a North European species found, at no great depth, in the West Indies. I could see no specific difference on comparing originals from Scandinavia.

SIGSBEIA gen. nov.

Disk small, covered with heavy plates or scales, and passing, without line of demarcation, into the stout arms, which can be rolled in a vertical plane. Teeth and mouth-papillæ ; no tooth-papillæ. Arms bearing the usual plates, and in addition a large supplementary piece extending downward from the upper arm-plate. Two genital openings in each interbrachial space, extending to margin of disk.

This singular genus forms a peculiar group with *Hemieuryale*, from which it is distinguished by having ordinary upper arm-plates, instead of a mosaic of small pieces. I have already pointed out (Ann. des Sc. Nat. 1872, p. 5) that it belongs with the Ophiuridæ, and yet Von Martens was right in saying that the rolling arms, passing, without line of demarcation, into the disk, suggested the simple-armed Astrophytidæ. Indeed, on examining the arm-bone joints, I find they offer a form approaching the double hour-glass joint of the true *Astrophyton*, which gives them their mobility in a vertical plane, despite their stiff, heavy plating.

Sigsbeia murrhina sp. nov.

Plate III. Figs. 55-58.

Special Marks. — Arms stout, and in length about six and a half times the diameter of the disk. Plates of body and arms thick, and often swollen and tuberculated. One tentacle-scale. Two arm-spines.

Description of an Individual. — Diameter of disk 12 mm. Length of arm about 80 mm. Width of arm close to disk 5 mm. Nine to eleven irregular crowded mouth-papillæ to each angle, the outer one on either side largest and resting on side mouth-shield, the innermost one at the apex of jaw, large, spearhead-shaped. Four or five stout, flat, blunt teeth, similar to the inner mouth-papilla. Mouth-shield broader than long, with an obtuse peak within and a blunt prolonged angle without; length to breadth 1.4 : 1.7. Side mouth-shields squarish, about as wide as long, meeting broadly within and having their lateral sides rounded. First under arm-plate much wider than long and much shorter than its successors: the next three or four are somewhat wider than long, slightly swollen, with inner edge straight; outer edge wider than inner and nearly straight, and lateral sides re-enteringly curved. Side arm-plates high, narrow, and swollen; above, they wedge in between the upper plates, and are shorter there and below than at their middle point. Upper arm-plates transverse-oval, much swollen, and covering only a part of the upper surface. The supplementary piece on either side of the upper arm-plate is large, swollen, tuberculated, larger than the side arm-plate, and extending downward to the arm-spines. At the tip of the arm it first appears as a granule somewhat smaller than an arm-spine; and it gradually increases in size to the base of the arm. Disk flat and angular, rising a little towards its centre, covered with thick, intimately soldered tuberculated plates having a porcelain surface; in the centre is a rosette of six primary plates, one rounded and swollen in the middle, and five wedge-shaped, encircling it and separated from each other by five raised rows of small tuberculated angular plates which run to the margin of the disk. Radial shields roughly triangular, large, with a blunt angle inward, separated their entire length by a raised row of angular plates; on their outer edge are two more, which are small, rounded, and swollen. The interbrachial spaces above are wholly covered by the five radiating rows of plates and by a part of the radial shields; and below by a few swollen scales. Genital openings extending to margin of disk; narrow and close-shut without, but broadening into a sort of pore at their inner end, and bounded by small, swollen genital scales. Two short, stout, rounded arm spines, standing low on the plate; they are about half as long as a side arm-plate, and the lower is a little the longer. One rounded, flat tentacle-scale on the inner side of the tentacle-pores. Color in alcohol, white with pale brown bands.

Sigsbee, off Havana, 175 fathoms, 4 specimens. The arms were rolled round *Stylaster filogranus*, which the animal mimics by its porcelain surface.

ASTROPHYTIDÆ.

Astroschema intectum sp. nov.

Plate III. Figs. 59-61.

Special Marks. — Arms very long and slender, granulated above, but naked on the sides and under surface.

Description of an Individual (Off Havana). — Diameter of disk 11.5 mm. Length of arm about 280 mm. Width of arm close to disk, without spines, 3 mm. Teeth longer than broad, with a curved cutting edge, the lowest one often split. Arms long and slender; the arm-joints are indicated by annular swellings. Radial shields long, and meeting in the centre; their granulation is finer than rest of disk, there being eight or nine in a mm. long, but only six or seven on the rest of the upper disk. Granulation on the arms more scattered and smaller, and confined to the upper surface, the sides and under surface being quite naked. No tentacle-scales usually on the first pair of arm-pores; on the second, and those beyond, there are two, long, blunt, and spiniform, whereof that on the brachial side is much the longer. This spiniform scale grows much larger toward the middle of the arm, but is never club-shaped. Genital openings short and wide. Color in alcohol, pale flesh with a disk grayish above.

Sigsbee, off Havana, 175 fathoms, 2 specimens.

Astroschema arenosum sp. nov.

Plate III. Figs. 62-64.

Special Marks. — Granulation coarse and rounded. Tentacle-scale of the interbrachial side growing long, but scarcely club-shaped.

Description of an Individual (Station 2). — Diameter of disk 9 mm. Width of arm close to disk, without spines, 4 mm. Teeth longer than broad, with a bluntly pointed cutting edge. Arms rather stout and of moderate length, but stiff with the coarse granulation which covers their entire surface; the joints are dimly indicated above and on the sides by slight swellings. Upper disk coarsely granulated about five grains in the length of a mm.; those on the arm are not so closely set. Radial shields not quite meeting in the centre, much wider without than within. Genital openings short, but rather wide. The first tentacle-pore has no scale; the next two have one, short, rounded, and spiniform; the rest have two, that of the interbrachial side being small: the other continues to grow larger till it equals two arm-joints in length, when it is thorny at the end, but scarcely swollen. Color in alcohol, white.

This species approaches nearest to *A. oligactes*, which has, however, a sharp, almost spine-like granulation, and much shorter tentacle-scales.

Station 2, 805 fathoms, 1 specimen. Station 35, 804 fathoms, 1 specimen.

Astroschema oligactes Ltk.

Asterias oligactes Pallas., Nova Acta Acad. Pet. II. p. 239.
Astroschema oligactes, Addit. ad. Hist. Pt. II. p. 155, Tab. V. Fig. 3. 1859.

Station 45, 101 fathoms, 12 + specimens.

Astroschema læve Lym.

Asteromorpha lævis Lym., Ann. des Sc. Nat. p. 3. 1872.
Astroschema læve, Ill. Catal. Mus. Comp. Zoöl. VIII. No. 2, p. 26. 1875.

Station 45, 101 fathoms, 1 specimen.

Ophiocreas lumbricus Lym.

Ophiocreas lumbricus, Bull. Mus. Comp. Zoöl. I. No. 10, p. 347. 1869. Ill. Catal. Mus. Comp. Zoöl. No. VI. Pl. I. Figs. 19–21. 1871.

Off Havana, 480 fathoms, 1 specimen.

Astrogomphus vallatus Lym.

Astrogomphus vallatus, Bull. Mus. Comp. Zoöl. Vol. I. No. 10, p. 350. 1869.

Station 6, 137 fathoms, 1 specimen.

DESCRIPTION OF PLATES.

PLATE I.

Fig. 1. *Ophiacantha scutata,* below ; $\frac{3}{1}$.
Fig. 2. " " above ; $\frac{3}{1}$.
Fig. 3. " " arm-joints ; $\frac{3}{1}$.
Fig. 4. *Ophiomitra exigua,* below ; $\frac{12}{1}$.
Fig. 5. " " above ; $\frac{12}{1}$.
Fig. 6. " " arm-joints ; $\frac{12}{1}$.
Fig. 7. *Ophiacantha echinulata,* below ; $\frac{12}{1}$.
Fig. 8. " " above ; $\frac{12}{1}$.
Fig. 9. " " arm-joints ; $\frac{12}{1}$.
Fig. 10. " *aspera* below ; $\frac{5}{1}$.
Fig. 11. " " above ; $\frac{5}{1}$.
Fig. 12. " " arm-joints ; $\frac{5}{1}$.
Fig. 13. *Ophiocamax histrix,* below ; $\frac{5}{2}$.
Fig. 14. " " above ; $\frac{5}{2}$.
Fig. 15. " " arm-joints ; $\frac{5}{2}$.

PLATE II.

Fig. 16. *Ophiomastus secundus,* below ; $\frac{8}{1}$.
Fig. 17. " " above ; $\frac{8}{1}$.
Fig. 18. " " arm-joints ; $\frac{8}{1}$.
Fig. 19. *Ophiozona (?) dubia,* below ; $\frac{7}{1}$.
Fig. 20. " " above ; $\frac{7}{1}$.
Fig. 21. " " arm-joints ; $\frac{7}{1}$.
Fig. 22. *Ophiopeza Petersi,* below ; $\frac{5}{2}$.
Fig. 23. " " above ; $\frac{5}{2}$.
Fig. 24. " " arm-joints ; $\frac{5}{2}$.
Fig. 25. *Ophiopsila fulva,* below ; $\frac{4}{1}$.
Fig. 26. " " above ; $\frac{4}{1}$.
Fig. 27. " " arm-joints ; $\frac{4}{1}$.
Fig. 28. *Amphiura tumida,* below ; $\frac{4}{1}$.
Fig. 29. " " above ; $\frac{4}{1}$.
Fig. 30. " " arm-joints ; $\frac{4}{1}$.
Fig. 31. " *lunaris,* below ; $\frac{10}{1}$.
Fig. 32. " " above ; $\frac{10}{1}$.
Fig. 33. " " arm-joints ; $\frac{10}{1}$.
Fig. 34. " *cuneata,* below ; $\frac{10}{1}$.
Fig. 35. " " above ; $\frac{10}{1}$.
Fig. 36. " " arm-joints ; $\frac{10}{1}$.

Fig. 37. *Ophiocnida abnormis*, below ; $\frac{9}{1}$.
Fig. 38. " " above ; $\frac{9}{1}$.
Fig. 39. " " arm-joints ; $\frac{9}{1}$.
Fig. 40. *Ophiochæta* (?) *mixta*, below ; $\frac{7}{2}$.
Fig. 41. " " above ; $\frac{7}{2}$.
Fig. 42. " " arm-joints ; $\frac{7}{2}$.

PLATE III.

Fig. 43. *Ophiozona tessellata*, below ; $\frac{4}{1}$.
Fig. 44. " " above ; $\frac{4}{1}$.
Fig. 45. " " arm-joints ; $\frac{4}{1}$.
Fig. 46. *Ophiomusium planum*, below ; $\frac{3}{2}$.
Fig. 47. " " above ; $\frac{3}{2}$.
Fig. 48. " " arm-joints ; $\frac{3}{2}$.
Fig. 49. *Ophioconis miliaria*, below ; $\frac{7}{2}$.
Fig. 50. " " above ; $\frac{7}{2}$.
Fig. 51. " " arm-joints ; $\frac{7}{2}$.
Fig. 52. *Ophiolipus Agassizii*, below ; $\frac{2}{1}$.
Fig. 53. " " above ; $\frac{2}{1}$.
Fig. 54. " " arm-joints ; $\frac{2}{1}$.
Fig. 55. *Sigsbeia murrhina*, below ; $\frac{5}{2}$.
Fig. 56. " " above ; $\frac{5}{2}$.
Fig. 57. " " arm-joints near base of arm ; $\frac{5}{2}$.
Fig. 58. " " arm-joints near tip of arm ; $\frac{5}{2}$.
Fig. 59. *Astroschema intectum*, below ; $\frac{5}{2}$. The first pore usually has no tentacle-scale.
Fig. 60. " " above ; $\frac{5}{2}$:
Fig. 61. " " arm-joints ; $\frac{5}{2}$.
Fig. 62. " *arenosum*, below ; $\frac{5}{2}$.
Fig. 63. " " above ; $\frac{5}{2}$.
Fig. 64. " " arm-joints ; $\frac{5}{2}$.

CAMBRIDGE, December 14, 1878.

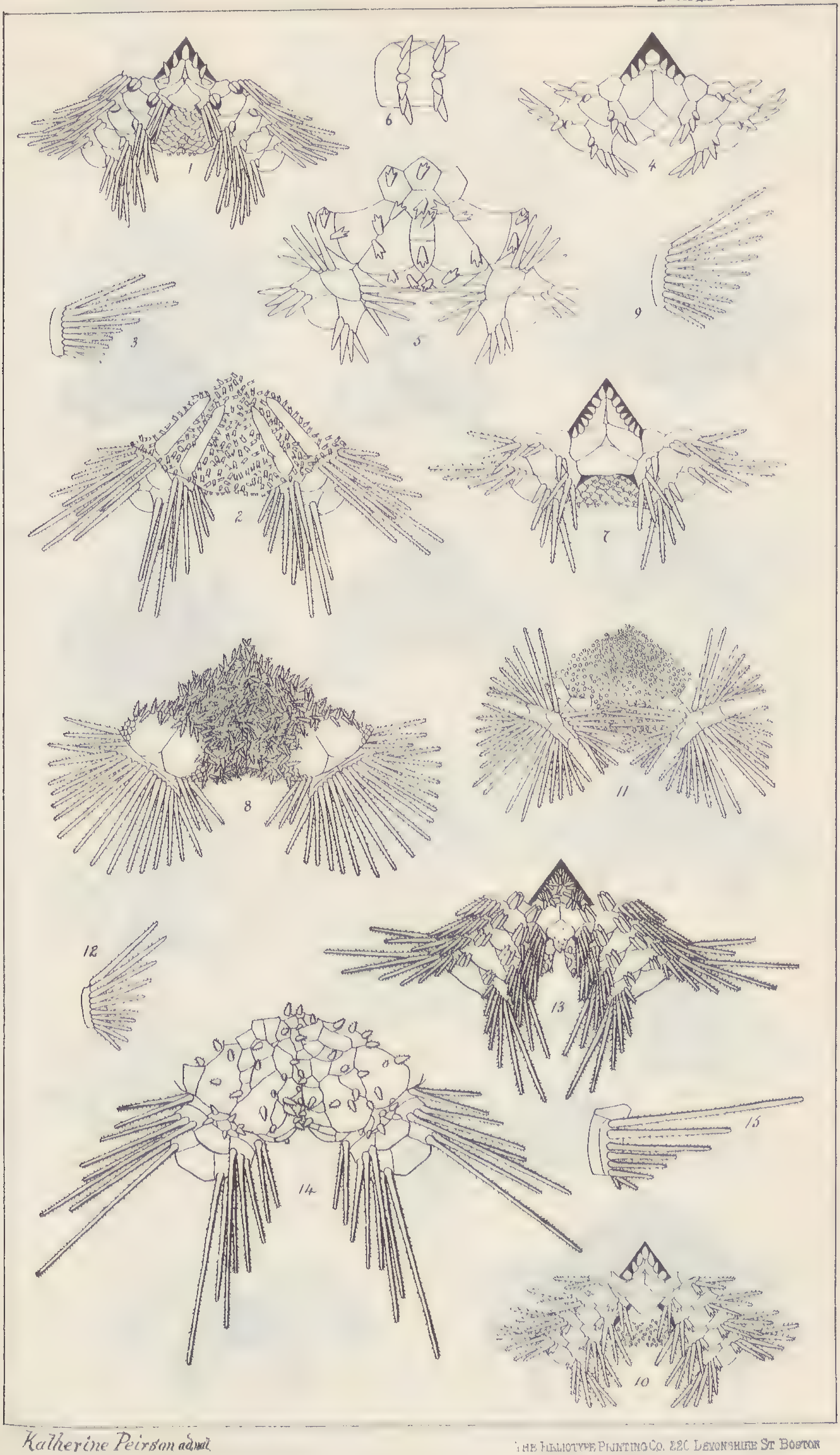


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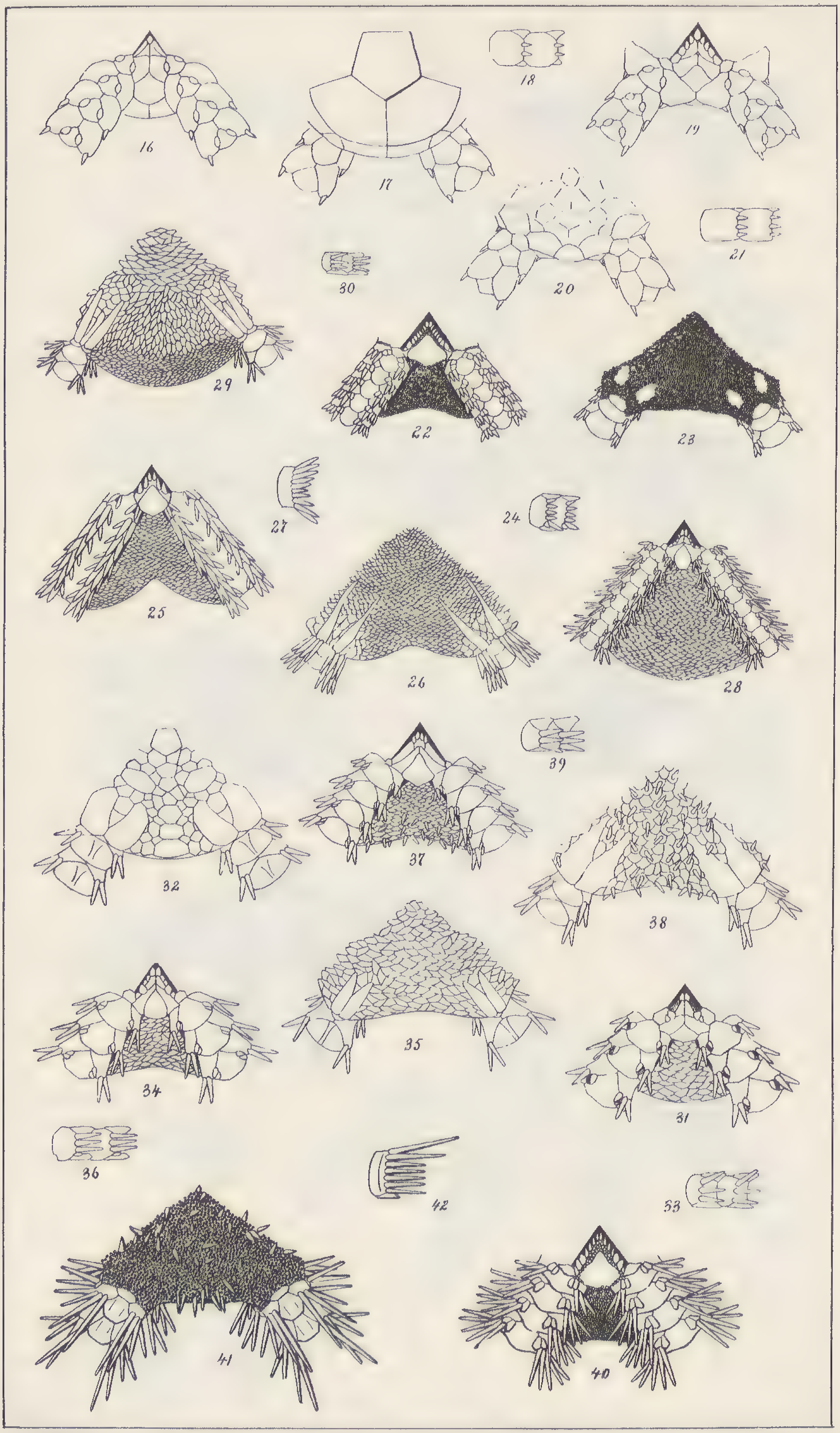
Plate II



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No. 10.—*Report on the Hydroida collected during the Exploration of the Gulf Stream and Gulf of Mexico by* Alexander Agassiz, 1877–78. *By* S. F. Clarke, *Fellow of Johns Hopkins University.*

Of the twenty-six species of Hydroida collected by Mr. Agassiz in the Gulf Stream and Gulf of Mexico in 1877–78, one half are described as new among the forms from the collection of Mr. L. F. de Pourtalès reported on by Professor Allman;* a similarity of fauna, which we would expect, owing to the close proximity and similar conditions of these regions.

Two of the remaining thirteen are well known to science, one is undeterminable, and ten are new.

Fourteen genera are represented, one of which, *Nematophorus*, is new. The species upon which this new genus is founded is the most interesting form in the collection, as it possesses a set of structures which from their position and form render it not improbable that they represent rudimentary hydrothecæ. The species are quite evenly divided among the comparatively large number of genera; only two of them being represented by more than two species,—*Lafoëa* with five, and *Aglaophenia* with four.

The *Plumularidan* is the dominant type; eight species, nearly one third of the collection, belonging to this family.

The following table contains a list of all the species in the collection, with the depths at which they were taken.

HYDROIDA.

GYMNOBLASTEA.

Pennaria symmetrica sp. nov.	*Tubularia* sp.
Eudendrium distichum sp. nov.	

CALYPTOBLASTEA.

Campanularia coronata sp. nov.	*Lafoëa robusta* sp. nov. 101 fms.
Obelia hyalina sp. nov.	" *serrata* sp. nov. 292 fms.
" *marginata* Allman.	" *venusta* Allman.
Lafoëa convallaria Allman, 101–177 fms.	*Halecium tenellum* Hincks, 36 fms.
" *gracillima* Alder, 101 fms.	*Cryptolaria conferta* Allman, 101 fms.

* Mem. Mus. Comp. Zoöl. Vol. V. No. 2. 1877.

Cryptolaria longitheca ALLMAN, 101 fms.
Sertularia distans ALLMAN, 36 fms.
" *complexa* sp. nov.
Sertularella amphorifera ALLMAN, 101 fs.
" *conica* ALLMAN, 36 fms.
Plumularia gracilis sp. nov.
Cladocarpus dolicotheca ALLMAN, 339 fms.
Cladocarpus tenuis sp. nov. 101 fms.
Aglaophenia apocarpa ALLMAN, 175 fms.
" *distans* ALLMAN, 539 fms.
" *rigida* ALLMAN, 339 fms.
" *gracilis* ALLMAN, 37 fms.
Nematophorus grandis gen. et sp. nov. 339 fms.

Pennaria symmetrica sp. nov.

Plate I. Figs. 2, 3.

Trophosome. — Hydrocaulus three, sometimes four inches high, occurring in dense clusters, which arise from a thick network of wiry, hydrorhizal filaments; deep black, becoming light horn-color at the tips; tapering but slightly towards the distal end, slightly zigzag, straight or very slightly curved; annulated at the base, and with a few, usually three, annulations just above the origin of each branch. Branches short, alternate, and with the distichous arrangement characteristic of the family; annulated at the base, and at the distal side of the origin of each ultimate ramulus. The ultimate ramuli all spring from the upper sides of the branches, are annulated at the base, and increase in size towards the distal end. Hydranths large, borne on the distal ends of the ultimate ramuli and those of the main stem and branches, largest at the base, tapering towards the mouth; filiform tentacles fourteen to eighteen, tapering but very little, if any, towards the distal end; capitate tentacles very short and about thirty in number.

Gonosome. — Unknown.

Locality. — Bahia Honda, Cuba.

The specimens form a thick cluster of dark-colored stems, considerably overgrown at the base and on the hydrorhiza with small sponges, ascidia, encrusting forms of polyzoa and annelid-tubes. A great many particles of coarse sand are by this means retained in the network of the hydrorhiza, thus indicating the nature of the bottom on which the colonies lived.

There is quite a close general resemblance between this form and the *Pennaria gibbosa* of L. Agassiz. But the zooids of this one have a symmetrical, not a gibbous-shaped body; the ultimate ramuli are annulated only at the base, *not* throughout; and the branches are not annulated at their distal ends. Still another difference is found in the position or point of origin of the filiform tentacles. In *P. gibbosa* they arise from the extreme base of the hydranth, while in the present form the point of origin is at some distance from the base.

Upon examining quite a large number of hydranths, I find that they vary in one particular. In some of them the filiform tentacles terminate in slightly, but distinctly swollen tips, while in others this feature is entirely wanting. Judging from alcoholic specimens, I am inclined to believe that this is due to the state of contraction they were in at death.

Eudendrium distichum sp. nov.

Plate I. Figs. 4-6.

Trophosome. — Hydrocaulus attaining a height of four to five inches, rooted by a creeping hydrorhiza, much branched, strongly curved, nearly the same thickness throughout, black at the base, passing through various shades of horn-color to white or a delicate yellowish-white at the distal end, annulated at the base and just above the origin of each branch; branches arranged alternately in a distichous manner, springing from the upper side of the stem, arched, with the convex sides towards the upper surface annulated above the origin of each ultimate ramulus. Ultimate ramuli short, with a peculiar bend in the proximal end which makes the proximal portion of the ramulus more or less parallel with the branch from which it originates, annulated at the base; the annulated part usually smaller than the rest of the ramulus. Hydranths large, with from sixteen to twenty tentacles.

Gonosome. — Unknown.

Locality. — Ten miles north of Zoblos Island.

Owing to the curved stem and branches and the freedom from all encrusting growths, this species is a very graceful, elegant one. From the regular distichous arrangement of the branches throughout the entire colony, it has the general appearance of a *Pennaria.* From all species of that genus it may of course be readily distinguished by a glance at the hydranths. From *E. ramosum* Linnæus, it is separated by the arrangement of the branches and by the general habit.

Tubularia sp.

The stems of a tubularian occur from two localities, — one from Yucatan; the other from a depth of 101 fathoms in Lat. 25° 33′ N., Long. 84° 21′ W.

Obelia marginata Allman.

A number of very fine specimens of this elegant species, forming a thick cluster of stems much overgrown and matted together near the base by encrusting bryozoa, ascidians, annelid-tubes, together with barnacles and lamellibranchs.

Creeping over some of the stems were found specimens of *Lafoëa venusta* Allman. This is the same species and as yet the only habitat on which this beautiful *Lafoëa* has as yet been found.

Locality. — Ten miles north of Zoblos Island.

Obelia hyalina sp. nov.

Plate IV. Fig. 21.

Trophosome. —Hydrocaulus springing from a creeping hydrorhiza, attaining a height of half an inch, but little branched, annulated at the base, divided into internodes of equal lengths, each one of which is annulated at its proximal end and bears on a short process from its distal end a pedunculated hydro-

theca. Branches arise in the axils of the hydrothecæ peduncles, are annulated at the base, and give origin to hydrothecæ, like the main stem. The pedicels of the hydrothecæ are annulated at both proximal and distal ends, and are occasionally annulated throughout. Hydrothecæ short, tapering towards the base; rim entire with an intrathecal partition toward the base.

Gonosome. — Gonangia small, about twice the length of the hydrothecæ, tapering slightly toward the base, rounded off at the distal end, with a simple, spherical, terminal opening which stretches entirely across the distal end, borne on short peduncles annulated throughout and arising from the axils of the hydrothecæ pedicels.

Locality. — Ten miles north of Zoblos Island.

This is a very delicate little form, so hyaline that it was only after prolonged staining that I was enabled to make out the structure of the very delicate hydrothecæ. I have referred it to this genus on account of the shape and structure of the contents of the gonangia, which are flattened and discoidal; the more advanced ones showing quite plainly that they are developing medusæ and not planulæ.

Campanularia coronata sp. nov.

Plate IV. Fig. 22.

Trophosome. — Hydrocaulus rooted by a creeping hydrorhiza, small and delicate, annulated at the base, bearing only a few pedunculated hydrothecæ; each pedicel annulated at its base and also at the base of the hydrotheca. Hydrothecæ deep, tubular, tapering but slightly to the rounded base, with seven or eight strong teeth surrounding the orifice. The edge of the aperture leading from the hydrotheca into the stem is ornamented with seven or eight spherical swellings of the perisarc.

Gonosome. — Unknown.

Locality. — Ten miles north of Zoblos Island.

The specific name is derived from a fancied resemblance in the ornamental aperture at the base of the hydrotheca to a crown.

Lafoëa serrata sp. nov.

Plate IV. Fig. 25.

Trophosome. — Hydrothecæ springing at occasional intervals from a creeping hydrorhiza; a proximal portion, varying from a third to a half of the entire length of the hydrotheca, is adnate to the hydrorhizal filament; the remaining free portion is bent at right angles to the adnate part and terminates in a slightly expanded orifice; the adnate portion is ornamented with a number of ridges or thickened elevations of the perisarc on the outer side.

Gonosome. — Unknown.

Locality. — Near Havana, Cuba. Depth, 292 fathoms.

This is a very elegant little species, and readily distinguished by the form and ornamentation of the hydrothecæ.

Lafoëa robusta sp. nov.

Plate IV. Fig. 24.

Trophosome. — Hydrothecæ large, tubular, tapering at the base, expanding slightly at the terminal orifice, borne on short, stout peduncles which arise at short intervals from the creeping hydrorhiza.

Gonosome. — Unknown.

Locality. — Long. 84° 21′ W. Depth, 101 fathoms.

This is a stout creeping form. The hydrothecæ are similar to those of *L. fruticosa* except in the characters of the peduncle. Occasionally there is an attempt at annulation seen in the peduncle, and there is considerable variation in the form of the hydrothecæ.

Lafoëa convallaria Allman.

Plate IV. Fig. 23.

One of the half-dozen fine specimens of this form in the collection bears a number of gonangia. The colony on which they occur is about two inches in height, and the gonangia are attached in a dense cluster to the main stem and to the bases of two or three of the branches ; they are sessile and anchor-shaped, with the orifices, of which there are two in each gonangium, at the extremities of the obtusely pointed flukes.

Localities. — Off Havana, Cuba, 160 – 177 fathoms. Lat. 25° 33′ N., Long. 84° 21′ W. Depth, 101 fathoms.

This style of gonangium is of unusual interest, as it is, I believe, the only one known with two external orifices, and any addition to our knowledge of the gonosomes of the *Lafoëidæ* is so seldom obtained that any new facts in this direction are very acceptable. It is somewhat remarkable that so little should be known in regard to the reproductive processes, and the structures in which they are developed, of a family in which there are such long-known and wide-spread species as occur in the *Lafoëidæ*. I have examined large quantities of *L. dumosa* from different parts of the world, taken at different depths, from waters of different temperatures, and at different seasons of the year, and yet, with all the examinations which have been made by various zoölogists, I believe we know nothing as yet of the gonosome. And the same is true of all other species of the genus, I think, with the exceptions of *L. calcarata* A. Agassiz, and *L. convallaria* Allman. These two forms are so different in style as to make it seem probable that when our knowledge of their life-histories becomes complete it may be necessary to separate them generically.

Lafoëa venusta Allman.

A few of the graceful hydrothecæ of this species were found creeping over the stem of *Obelia marginata*, collected ten miles north of Zoblos Island.

Lafoëa gracillima Alder.

A number of fine specimens of this delicate form were taken in Lat. 25° 33 N., and Long. 84° 21′ W., at a depth of 101 fathoms. No gonangia present.

Halecium tenellum Hincks.

This well-known species is represented in the collection by a small specimen from Lat. 24° 34′ N., Long. 83° 16′ W. Depth, 36 fathoms.

Cryptolaria longitheca Allman.

Plate II. Figs. 7-10.

Very good representatives of this species were collected in Lat. 25° 33′ N., and Long. 84° 21′ W., at a depth of 101 fathoms.

The hydrothecæ differ from Professor Allman's description and figure, but agree with his type-specimen in tapering towards the base. See Plate II., Figs. 7 to 10.

Some of the hydrothecæ are extended to twice their original length by the addition of a number of annular processes; in some cases as many as twenty being found upon one hydrotheca.

Clustered upon the upper portions of the stem of one of the finest specimens were a number of peculiar bodies, very like in character to the similar bodies described by Professor Allman as occurring on the stems of *C. conferta.* They are polygonal in form, largest at the distal end, tapering to the base, crowded so closely together that the walls of adjoining bodies are in contact throughout their length, and are provided with a small tubular orifice arising from the centre of the distal end; at the base they are connected by branching stolons, but I was unable to make out any connection between these remarkable bodies and the stems of *Cryptolaria* upon which they were growing.

The fact of these two slightly different forms of these peculiar colonies having been found upon these two closely allied forms of *Cryptolaria* is an argument in favor of the suggestion of Professor Allman, that these bodies are the gonangia of the species of *Cryptolaria* to which they are attached, and that there may exist some communication between them as yet undiscovered. I worked with great care on sections, transverse, longitudinal, and oblique, of cleaned and stained specimens, but was unable to detect any connection between them.

There is the same method of lateral communication between the stems in this species as is described in *C. conferta.*

Cryptolaria conferta Allman.

Plate III. Figs. 14-20.

A few specimens of this interesting form were obtained in Lat. 25° 33′ N. and Long. 84° 21′ W., at a depth of 101 fathoms. In general outline the specimens from the above-named locality agreed so closely with the figure given by Professor Allman from the type specimen, that I had but little doubt in regard to their identity; but with the original description they do not agree in structure. After careful study of many specimens, some of which contained the cœnosarc so well preserved that it greatly assisted me in making out the con-

nections between the cavities of the hydrothecæ and those of the stem and also between the different stems through their lateral communications, while others were carefully cleaned of their contents and stained with eosine, and of still others numerous cross-sections were also made, I arrived at the following results. The basal portion of the main stem and of most of the branches are polysiphonic, and these cauline tubes decrease in number towards the distal extremities until they are but two, then one, and finally they are all discontinued; where two exist, they are found to occupy opposite sides of the branch, one on the upper and one on the lower surface, the hydrothecæ imbedded in and stretching out from the sides of the branches; where one only is left, it usually occupies the upper surface of the branch. These cauline tubes are provided with a number of perforations, regularly arranged, by means of which they have direct communication with the contents of each hydrotheca. Where but one tube exists, the perforations may readily be seen in the floor of the tube or stem, one near the base of each hydrotheca and towards the opposite side of the stem from which the hydrotheca near whose base it lies is imbedded; they are therefore arranged alternately on opposite sides of the tube. See Plate III. Figs. 16, 20.

Where there are two tubes of the stem, an upper and a lower, there is an orifice in the lower tube directly opposite each one in the upper tube, and through these apertures there extend processes of the cœnosarc which communicate with each other and with the neighboring hydrothecæ. By this means direct and abundant communication is established between all portions of the cauline stems and the hydrothecæ. By the aid of the cross-sections I find that the walls of the cauline stems, where there are two of them, never adjoin one another, while the walls of the opposite hydrothecæ do touch throughout. See Plate III., Figs. 17 *b*, *c*, *d*.

Thus far the structure described does not disagree with anything given in Professor Allman's description, but careful camera-lucida sketches of front views of portions of the extremities of the branches where the cauline tubes are discontinued do not indicate any floor to the hydrothecæ, but show them to be fully open below without a floor. Still more distinctly and conclusively is this shown in a camera-lucida drawing of a lateral view. See Plate III., Fig. 18.

Figs. 19 and 20 on Plate III. are from the type specimens, showing the same structure. In Fig. 19, Plate III., the uppermost hydrotheca belongs to the right side of the branch, the median and lower ones to the left side. In Fig. 18, Plate III., the hydrothecæ of one side only are represented.

Sertularia complexa sp. nov.

Plate IV. Figs. 26-28 *b*.

Trophosome. — Hydrocaulus attaining a height of about three quarters of an inch, unbranched, divided by transverse nodes into rather short internodes; hydrothecæ not springing from opposite sides, but imbedded in one side of the stem, deep, the lower halves of each pair resting against each other, the distal

portions free and tapering toward the bilabiate mouth; chitinous processes extend downwards from the base of each hydrotheca, surrounding an aperture through which the body of the polypite is connected with the cœnosarc of the stem.

Gonosome. — Unknown.

Locality. — Yucatan. Attached to an Alga.

This form has a general resemblance to *S. pumila*, but a glance suffices to show that the likeness is a superficial one. The internal chitinous ridges are quite peculiar and characteristic, and with the aid of the different views given in the figures may be readily understood.

Sertularia distans Allman.

A small cluster of eight to ten stems of *S. distans*, three quarters of an inch high, without gonangia, were collected near the Tortugas Islands in a depth of 36 fathoms. Lat. 24° 46 N., Long. 83° 16′ W.

Sertularella amphorifera Allman.

This is one of the most abundant species in the collection; a considerable number of very fine specimens with gonangia having been taken at a depth of 101 fathoms.

Locality. — Lat. 25° 33′ N., Long. 84° 21′ W.

Sertularella conica Allman.

A single small specimen of this form, half an inch in height, occurred from a depth of 36 fathoms in Lat. 24° 34′ N. and Long. 83° 16′ W.

Plumularia gracilis sp. nov.

Plate V. Figs. 29-30 *c*.

Trophosome. — Hydrocaulus minute, one third of an inch in height, stout, tapering towards the distal end, the basal portion divided by transverse joints into internodes of unequal length, the upper portion from a point just below the origin of the first branch divided by very oblique nodes into internodes of quite regular length; these internodes of the upper part of the stem each give origin to a pair of branches which arise opposite each other on the sides of the stem; on the upper surface of the stem between the bases of the branches is borne a hydrotheca, and near its base on the upper surface of the proximal portion of the internode is borne a single nematophore, while in front of the hydrotheca on the upper surface of the same internode are borne three nematophores all arising from the median line; these cauline hydrothecæ have a pair of nematophores, which are supported on processes from the stem that arise on the front edge of the hydrothecæ. The branches are divided very obliquely into internodes, of which the basal or proximal one gives rise to two nematophores which spring from the median upper surface; the others bear each a hydrotheca with its pair of supra-calycine nematophores, a single nematophore

on the proximal side of the hydrotheca and one on the distal side. Hydrothecæ tubular, with an entire margin which is slightly depressed on two opposite sides.

Gonosome. — Unknown.

Locality. — Off Havana, Cuba. Depth, 175 fathoms.

This species is closely allied to *P. geminata* Allman, but differs in the arrangement of the branches, which in this form arise from opposite sides of the stem and lie nearly in the same plane, curving but slightly upwards. The arrangement of the internodes on the branches is also different, as is the arrangement of the nematophores.

Cladocarpus tenuis sp. nov.

Plate V. Figs. 31, 31 *b*.

Trophosome. — Hydrocaulus attaining a height of an inch and a half, very delicate, pale straw-color, the lower portion bearing a row of nematophores, the upper portion giving rise to branches arranged alternately, and with three or four very oblique internodes just below the branched portion ; the branches or pinnæ undivided. Hydrothecæ deep, slender, tubular, smallest in the centre and tapering both ways, largest at the distal end, a crenate rim and a large rectangular or obtusely pointed median tooth ; each hydrotheca overarched by the portion of the pinna which intervenes between it and the next. Supracalycine nematophorès prominent, extending above the edge of the hydrotheca ; mesial nematophore of about the same size of the supra-calycine, and attached to the enlarged portion of the pinna just below the hydrotheca. The pinnæ are ornamented with a great number of internal chitinous ridges.

Gonosome. — Unknown.

Locality. — Lat. 25° 33′ N., Long. 84° 21′ W. Depth, 101 fathoms.

This species is closely allied to *C. dolicotheca* Allman ; it being similar in every respect in regard to the trophosome, with the exception of the shape of the hydrothecæ, and its having a more slender habit. These characters are very constant, and are sufficient to enable it to be readily distinguished.

Cladocarpus dolicotheca Allman.

This species is represented in the collection by a single fine specimen from a depth of 339 fathoms, taken in Lat. 24° 8′ N., and Long. 82° 51′ W.

Aglaophenia apocarpa Allman.

This species is well represented by some half-dozen colonies with corbulæ which are attached to what appears to be a much-worn outer investment of some gorgonia-like or other branched form. They are about three inches in height, and in good, clean condition.

Locality. — Off Havana, Cuba. Depth, 175 fathoms.

Aglaophenia distans Allman.

Two fine specimens with their very long pinnæ were dredged in a depth of 539 fathoms, Lat. 25° 33′ N., Long. 84° 35′ W.

Aglaophenia gracilis Allman.

A very fine specimen of this form, seven and a half inches high, was dredged in Lat. 24° 43′ N. and Long. 83° 25′ W. Depth, 37 fathoms. No corbulæ present.

Aglaophenia rigida Allman.

There are two specimens of *A. rigida* in the collection, — one of them, nearly stripped of its pinnæ, is eight and a half inches in length ; the other is smaller, but in much better condition. No corbulæ present.

Localities. — Ten miles north of Zoblos Island. Lat. 24° 8′ N., Long. 28° 51′ W. Depth, 339 fathoms.

NEMATOPHORUS S. F. Clarke. nov. gen.

Trophosome. — Hydrosoma pinnate, plumose ; stem and pinnæ divided into internodes. Hydrothecæ adnate to the pinnæ, unilateral. A peculiar rounded process at the base of each pinna, with a small opening on the median line near the inner or proximal end. Supra-calycine, mesial, and cauline nematophores present.

Gonosome. — Not known.

This genus is closely allied to *Aglaophenia* as seen in the arrangement of the calycine nematophores, the hydrothecæ, and in the general habit ; but is separated from these, as it is from all other forms, by the peculiar processes borne on the bases of the pinnæ. The cauline nematophores, too, in the single species known, are of such a peculiar character that I think it possible there may prove to be something of genetic value in them.

Nematophorus grandis sp. nov.

Plate V. Figs. 32-35.

Trophosome. — Hydrocaulus large, tree-like, polysiphonic, attached by a dense network of creeping hydrorhizal filaments, black and thickest at the base, changing to light horn-color as it tapers towards the distal end ; attains a height of twelve inches in the finest specimens, sparingly branched ; branches alternate, arising from the upper surface of the stem ; those given off near the base are largest and resemble the main stem in all particulars, the upper ones shorter, all of them bearing branchlets, and these are also branched always alternately ; branches and branchlets all gracefully curved, all polysiphonic at the base and tapering towards the distal end, where they become monosiphonic ; branches and branchlets divided by transverse nodes into short internodes, each of which gives origin to a pinna ; pinnæ arranged alternately, and arise from the upper surface of the branch ; they are but very slightly arched, nearly in the same plane, of a nearly equal length throughout the greater part of the branch, becoming rather abruptly shorter near the distal end. Hydrothecæ arranged unilaterally upon the pinnæ, one to each internode, closely set, deep, slightly

widening towards the oblique orifice ; the outer portion of the margin cut into five rather shallow teeth, intrathecal ridge strong and continuous with one across the stem of the branch. Nematophores are found in connection with the hydrothecæ, and upon the stems ; supra-calycine nematophores very large and prominent, stretching far beyond the edges of the hydrothecæ, orifice terminal and continued laterally on the inner side towards the pinna ; mesial nematophore large and strong, extending above the edge of the hydrotheca, adnate throughout, orifice like those of the supra-calycine nematophores ; cauline nematophores quite variable in form, two on each internode, more or less triangular, with rounded or with one of the upper corners greatly produced, tapering towards the base ; external orifice very large, extending entirely across the upper margin and into the lateral processes, when the latter exist ; the opening from the cavity of the nematophore into the stem is also very large, often being equal in size to the internal orifice of the hydrothecæ. At the base of each pinna, in a direct line with the hydrothecæ, is an oval swollen process, with a small circular orifice on the upper surface near the proximal end ; its cavity is directly continuous with that of the hydrotheca in front of it, and also with that of the stem.

Gonosome. — Unknown.

Localities. — Ten miles north of Zoblos Island. Lat. 24° 8′ N., Long. 82° 51′ W. Depth, 339 fathoms.

The most prominent feature of this interesting species is the great development of the nematophores. Those in connection with the hydrothecæ are above the average size, and those of the stems are among the largest known ; the peculiar processes borne on the bases of the pinnæ may also perform the functions of nematophores, but until live specimens have been examined it will be impossible to say. Of the two cauline nematophores found upon each internode the proximal one has always the more regular outline, owing probably to the fact that on this portion of the internodes there is an abundance of room for them to develop in every direction, while those situated on the distal end are limited in their growth in one direction by the basal processes of the pinnæ. This will readily be seen by reference to the figure. It is also worthy of notice that the corner of the distal cauline nematophore which is most strongly produced is the one on the opposite side to the base of the pinna. By stretching out in this direction it reaches a freer space in which to manipulate the protoplasmic processes which it may send forth.

The cœnosarc of the most proximal hydrotheca on each pinna finds its way to the cœnosarc of the main stem by passing directly through the cavity of the oval basal process, and from the size of the opening of the basal process I imagine that it must be used for the protrusion of protoplasmic processes like those from an ordinary nematophore. The process differs, however, from the ordinary nematophores in containing a portion of true cœnosarc, and to this extent it approaches the nature of a hydrotheca ; that is, there exists a swollen, oval process of the perisarc, containing a process of the cœnosarc, and with (what in all probability is) a mesial nematophore upon its upper surface. It

appears to be, then, a structure which we may look upon as a rudimentary hydrotheca; moreover, this view receives support from the position of these processes, that is, at the bases of the hydrotheca-bearing portions of the colony, with the contents of the hydrothecæ in immediate connection with that of these basal processes.

After the very valuable suggestions of Professor Allman * on this point it is not difficult to conceive that the pinnae of *N. grandis* may at one time have borne only oval processes of a large and peculiar type, much like the oval basal processes now found on the bases of the pinnæ, and that these have been gradually developed into true hydrothecæ. The development of the upper corners of the cauline nematophores indicate how the supra-calycine nematophores may have been produced.

The contents of one of the mesial nematophores with its extruded protoplasmic processes has been so well preserved that I have been able to get an accurate camera-lucida sketch of it (Plate V., Fig. 35). It has the same structure apparently as those figured by G. O. Sars † in his *Lafoëina tenuis.*

* Gymnoblastic Hydroids, Ray Society, p. 176 et seq. Hydroids of the Gulf Stream, in Mem. Mus. Comp. Zoöl. Vol. V. No 2, p. 51.

† Bidrag til Kundskaben om Norges Hydroider, Af G. O. Sars. Tab. V. Figs. 4, 5.

Cambridge, January 10, 1879.

EXPLANATION OF THE PLATES.

All the figures were drawn with the aid of the camera-lucida, and with the exception of Figs. 1 and 35 were enlarged fifty-five diameters. With the same exceptions, all are *represented* as enlarged thirty diameters.

PLATE I.

Fig. 2. A portion of the trophosome of *Pennaria symmetrica : a*, main stem ; *b*, branch ; *c*, ultimate ramulus or pedicel.

Fig. 3. Hydranth of *P. symmetrica*, showing the capitate and filiform tentacles and the large body of the hydranth. This specimen had been somewhat flattened by pressure, so that one or two more of the filiform tentacles appear than are usually seen in such a view.

Fig. 4. Portion of trophosome of *Eudendrium distichum : a*, large trumpet-shaped hypostome, a family characteristic ; *b*, ultimate ramulus with its narrowed, annulated base ; *c*, portion of a branch.

Fig. 5. The same ; letters as in Fig. 4 : *d*, the mouth at the extremity of the large hypostome.

Fig. 6. A portion of the main stem of *E. distichum : a*, main stem ; *b*, branches.

PLATE II.

Fig. 7. Portion of a branch of *Cryptolaria longitheca* Allm. The specimen is peculiar in the very large number of additions which have been made to the hydrothecæ, thereby making some of them twice their original length. In the original condition the free portion is about equal, or a little greater in length than the part imbedded in the stem.

Fig. 8. Is a more typical form of the same, from the same locality.

Fig. 9. Two somewhat abnormal hydrothecæ from the extremity of a branch of the same specimen as Fig. 8.

Fig. 10. The same, from Professor Allman's type-specimen.

Fig. 11. A colony of the peculiar gonangia-like organisms found attached to the stems of *Cryptolaria longitheca* Allman.

Fig. 12. A longitudinal section through the stem and portion of the colony of Fig. 11 : *a*, apertures through which the vessels communicate by a network of stolons at their bases.

Fig. 13. A transverse section of the same : *b*, sections of the stem of *C. longitheca* upon which they were growing : *a*, sections of the root-like stolons of the gonangia-like colony.

PLATE III.

Fig. 14. The distal end of a branch of *Cryptolaria conferta* Allman : *a*, the distal end of the cauline tube.

Fig. 15. An unusually large form of the same.

Fig. 16. The same, but from a basal portion of a small branch : *a*, the cauline tube ; *b*, the lateral communications between the cauline tube and the hydrothecæ. The specimen from which this figure was made has another cauline tube on the under surface of the branch, but as its outlines, like those of the orifices of the lateral communications, are exactly beneath those upon the upper surface, they cannot very well be represented.

Figs. 17 *b, c, d.* Represent a number of cross-sections of stems of *C. conferta*, taken from specimens having two cauline tubes. *s, s*, indicates the tubes in each, and *h, h*, the hydrothecæ. It will be observed that the hydrothecæ are always, and the cauline tubes never, in contact.

Fig. 18. Portion of the branch of the same. A lateral view showing the nature of the internal orifice of the hydrothecæ.

Fig. 19. A lateral view of the same from Professor Allman's type specimen.

Fig. 20. Portion of a branch of *C. conferta* from near the distal end ; from Professor Allman's type specimen.

PLATE IV.

Fig. 21. *Obelia hyalina : a*, main stem ; *b*, branch ; *c*, gonangium ; *d*, developing medusæ.

Fig. 22. *Campanularia coronata : a*, hydrocaulus ; *b*, branch ; *c*, hydrorhiza.

Fig. 23. One of the peculiar gonangia of *Lafoëa convallaria : a, a*, the two external orifices ; *b*, the point of attachment to the stem.

Fig. 24. *Lafoëa robusta :* five forms showing considerable specific variation.

Fig. 25. *Lafoëa serrata.*

Figs. 26, 26 *b.* *Sertularia complexa ;* view of upper surface of branch : *a, a*, orifices by which hydrothecæ communicate with stem or tube of the branch.

Fig. 27. The same ; lateral view : lettering as before.

Figs. 28, 28 *b.* Front and back views respectively of the same : *b*, the cut end of the stem.

PLATE V.

Fig. 29. The proximal part of the main stem of *Plumularia gracilis*, showing the thick chitinous walls of the perisarc and the transverse nodes.

Fig. 30. Part of the upper or distal portion of the same, with very oblique nodes.

Fig. 30 *b*. Lateral view of a hydrotheca of same.

Fig. 30 *c*. Lateral view of portion of a branch showing arrangement of internodes in the branches.

Fig. 31. *Cladocarpus gracilis ;* lateral view.

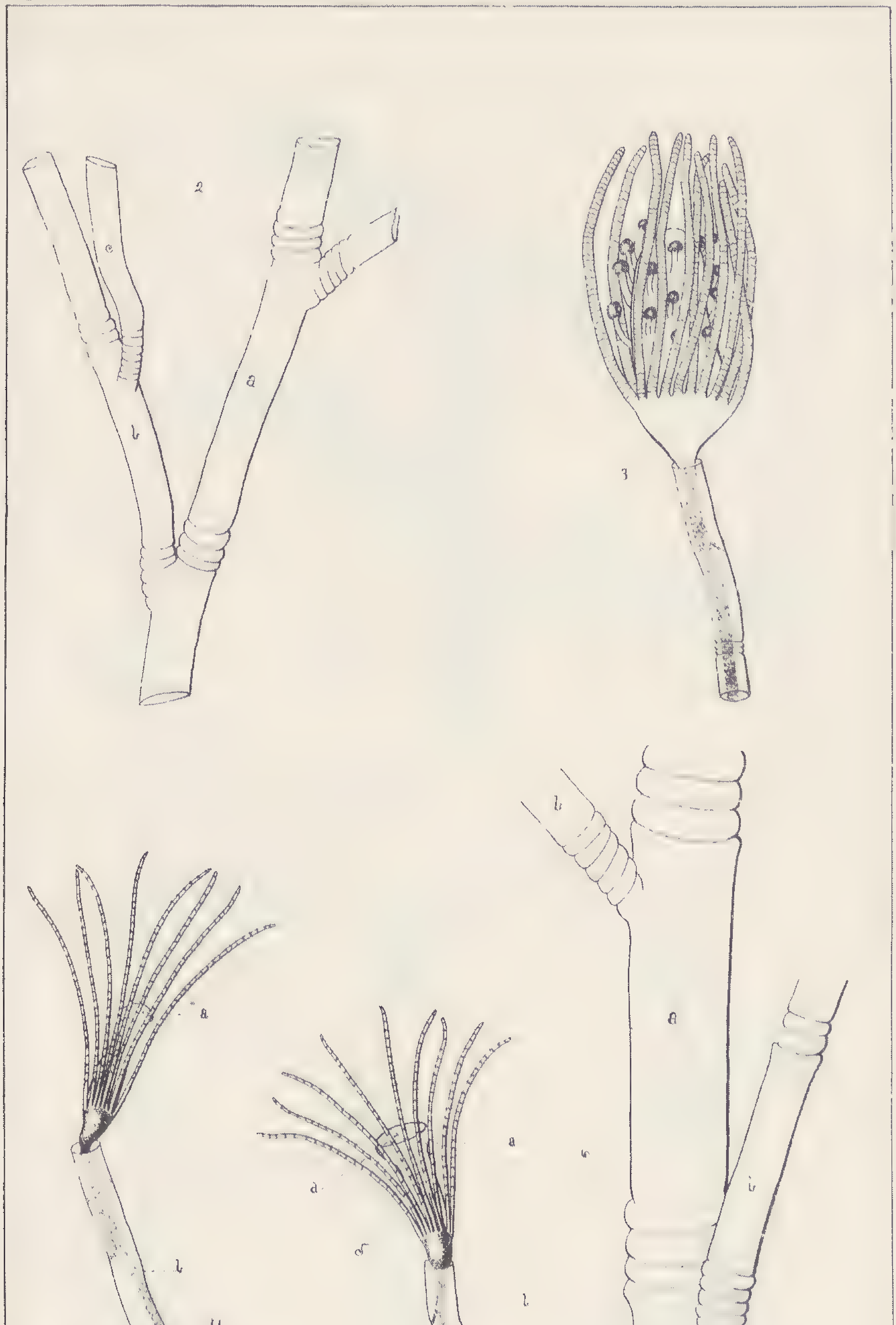
Fig. 31 *b*. The same ; front view.

Fig. 32. Lateral view of portion of a pinna of *Nematophorus grandis.*

Fig. 33. Front view of the same.

Fig. 34. Portion of main stem of the same : *a, a, a, a, a*, oval bodies with mesial nematophore openings ; *b, b, b*, cauline nematophores ; *c, c, c, c*, internal orifices of the latter ; *d, d*, external orifices of the cauline nematophores ; *e*, lateral view of a cauline nematophore.

Fig. 35. An enlarged view of a small part of a pinna of *N. grandis*, showing the contents of a mesial nematophore as they were preserved in alcohol.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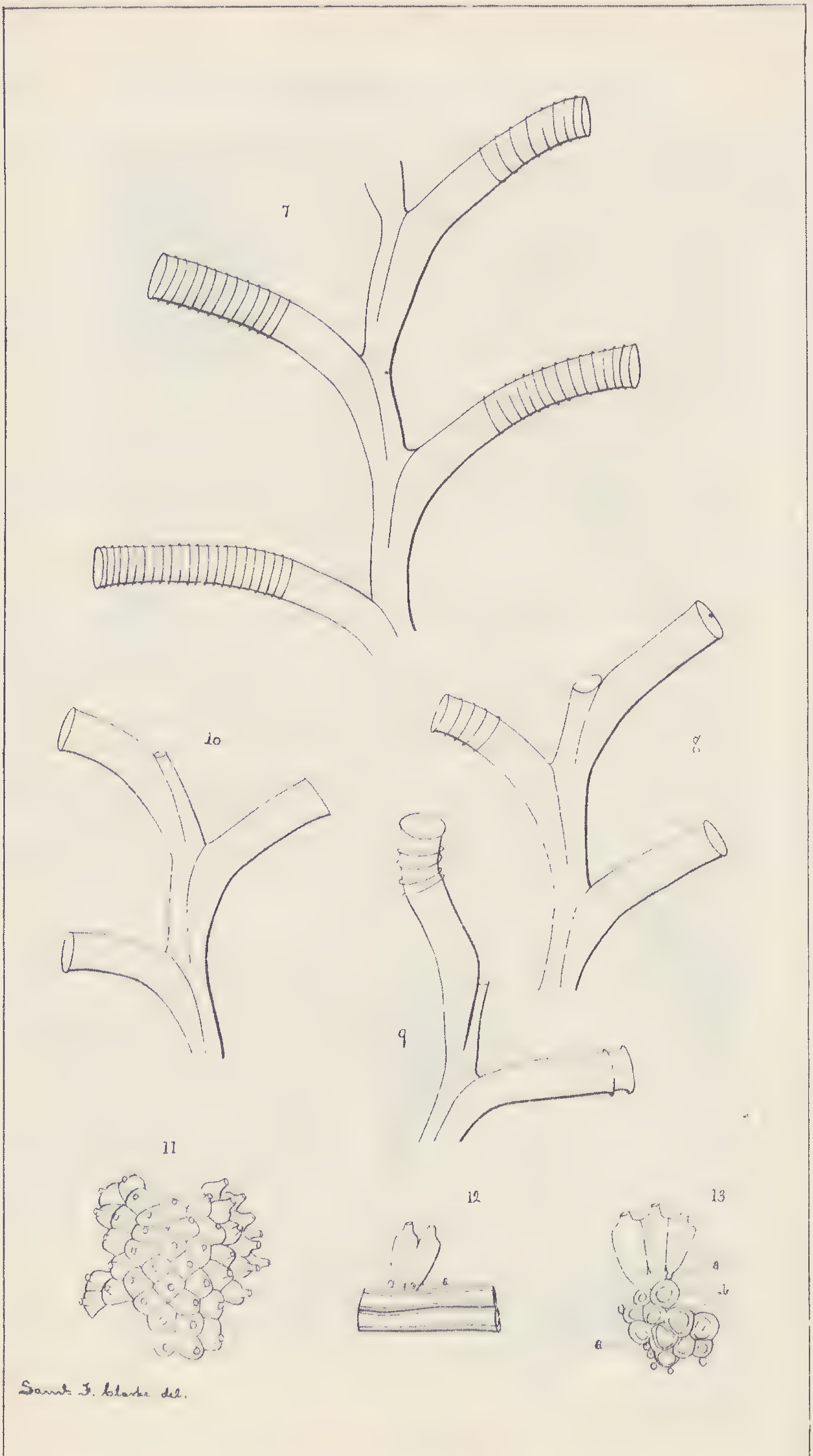
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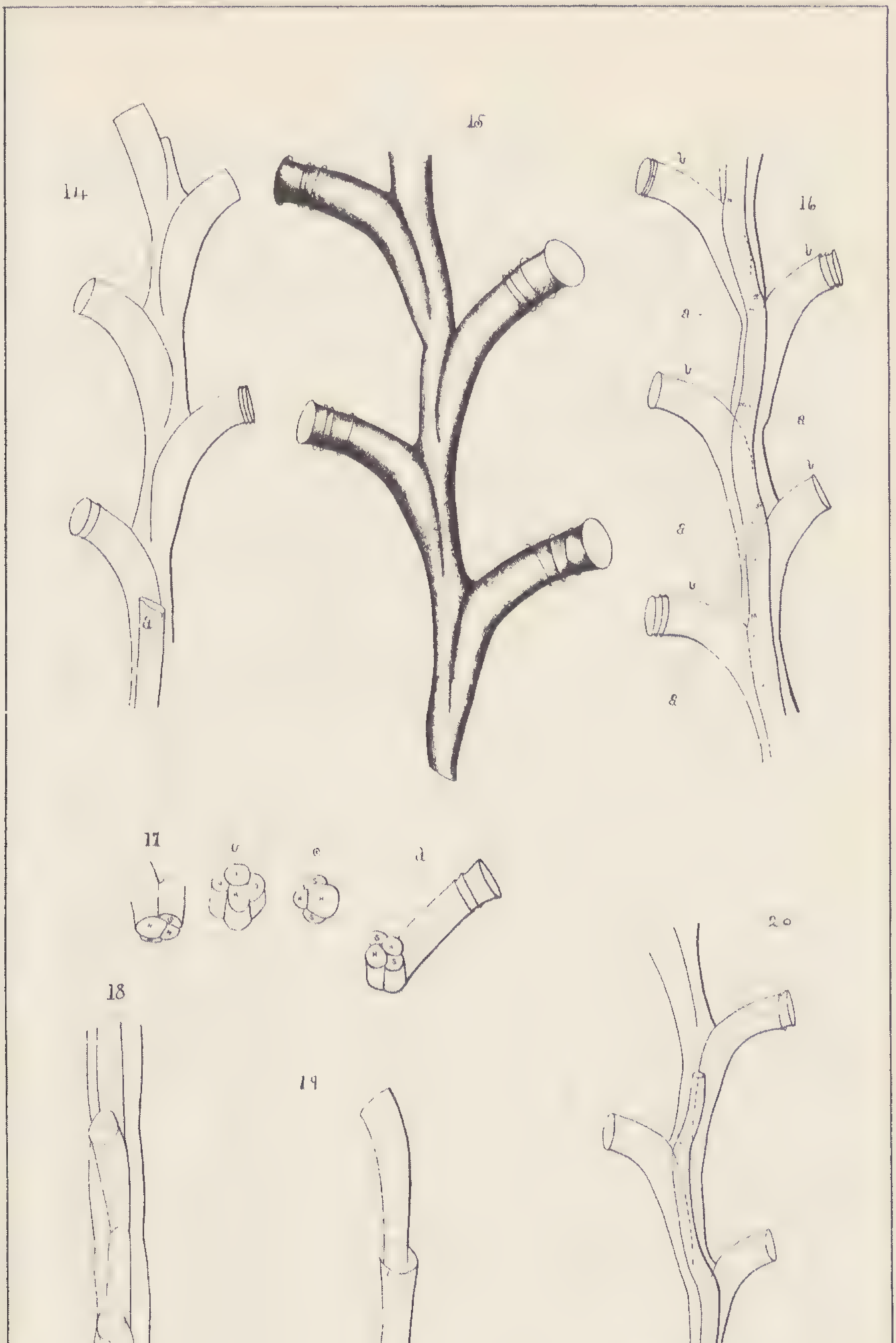
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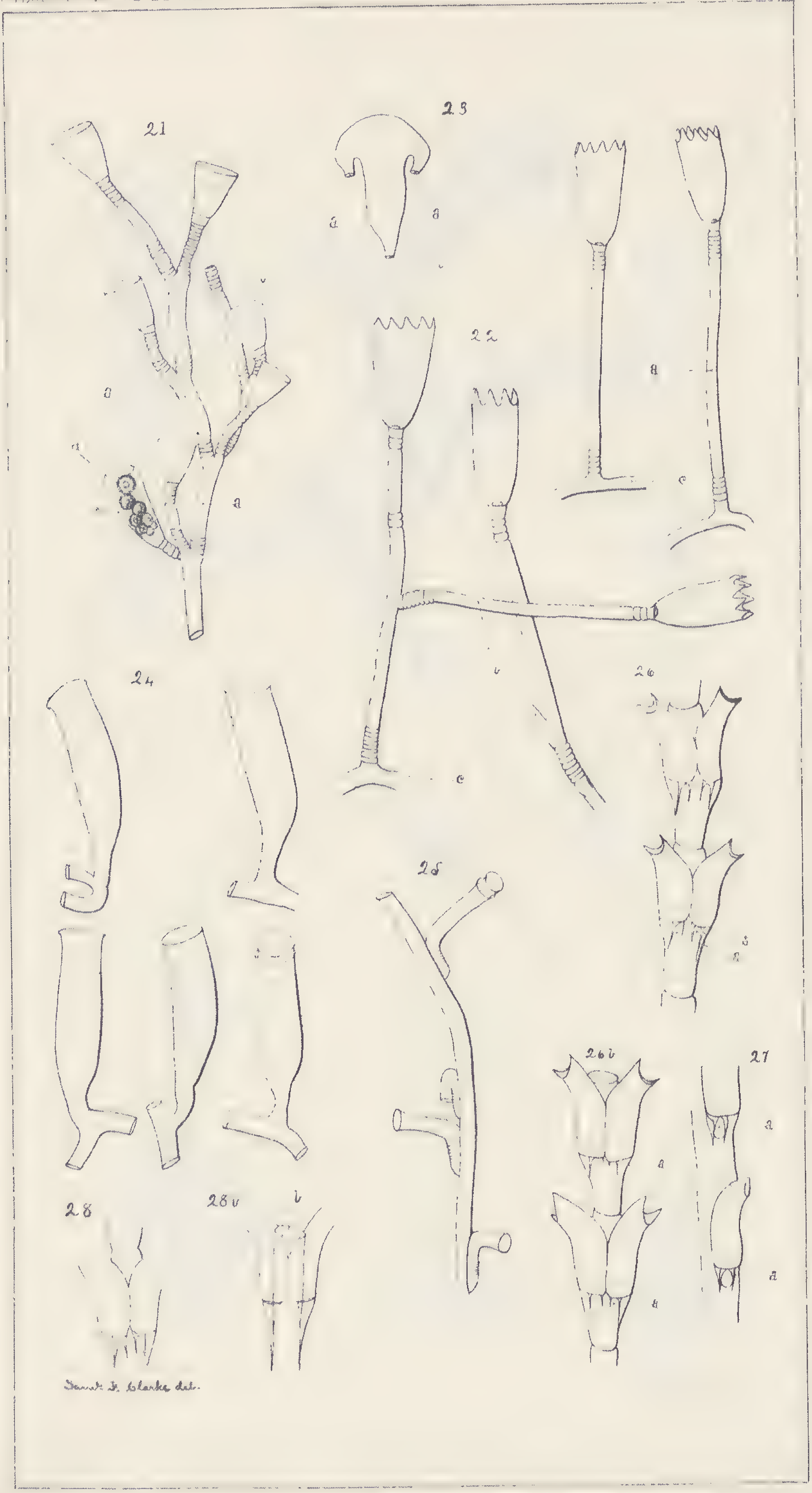
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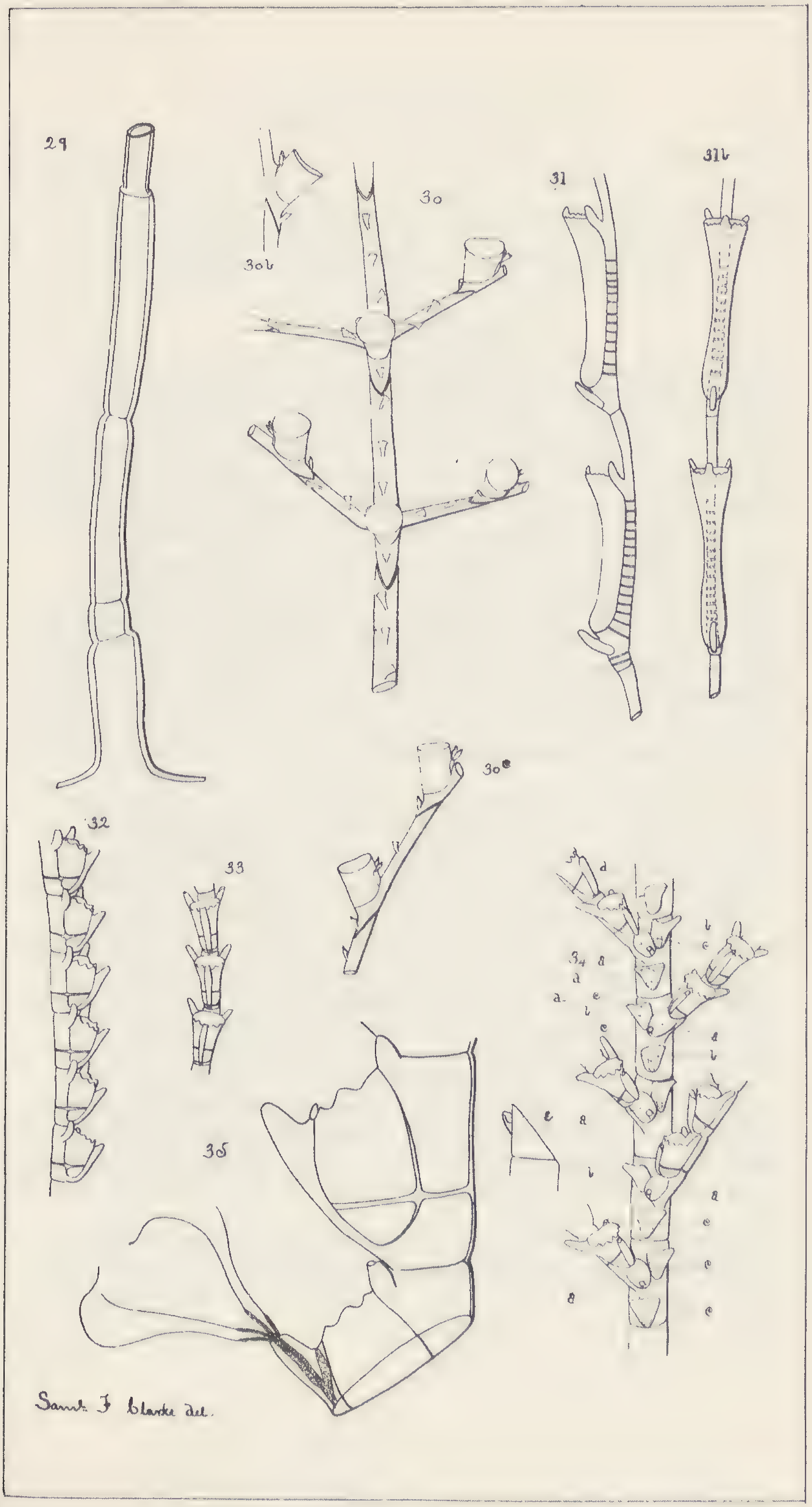
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No. 11. — *On some Young Stages in the Development of* Hippa, Porcellana, *and* Pinnixa. *By* Walter Faxon.

I. Hippa talpoida.

During the month of August, 1877, I procured large numbers of *Hippa talpoida* on the bathing-beach near Nobska Point, Wood's Hole, Massachusetts, the locality made known by Professor S. I. Smith. Among them were many ovigerous females, from which I obtained the first stage of the larva. As a supplement to Professor Smith's paper on the early stages of this animal,* I present the following description and figures of the first zoëa-stage, Smith's series beginning with what he presumes to be the second zoëa-stage.

The carapace (Plate I. Figs. 5, 6, 15) is oval, smooth, strongly convex above, curving downward and inward on the sides. It sends a long blunt process forward below the eye-stalks (Plate I. Fig. 6 *b*). Behind, it presents a deep sinus for the accommodation of the abdomen (Plate I. Fig. 15 *b*). Anteriorly it is produced between the eye-stalks into a short, broad, rather blunt rostrum. The carapace has no dorsal or lateral spines. At the points where the lateral spines appear after subsequent moults, there is a thickening of the integument, producing a very slight bulge on the outer surface, a stronger one within (Plate I. Fig. 15 *a*).

The abdomen has nearly the same form as in the later stages of the zoëa. It consists of but five segments, counting the telson. The first abdominal segment of the adult is fused with the second or with the thorax, the sixth with the telson. The fourth segment in the abdomen of the larva is considerably wider behind than in front. The telson is quite different from the telson as seen in Smith's figures of the later stages. Its breadth now slightly exceeds its length, and the curve of the sides is such that nearly the maximum width is reached but a short distance from the anterior border. From the middle it narrows slightly posteriorly, to be produced at the posterior angles into a stout tooth. As in the later stages, the convex posterior margin of the telson is furnished with spines and minute teeth (Plate I. Figs. 13, 14). The number of spines is the same as in the later stages, namely, twenty-six, the eighth, counting from either side, being the longest; but the number of denticles between the spines is much less than in the later stages. Starting with the single median denticle, the spines are separated by single denticles until the tenth spine is

* The Early Stages of *Hippa talpoida*, with a note on the Structure of the Mandibles and Maxillæ in *Hippa* and *Remipes*. By Sidney I. Smith. Trans. Conn. Acad. III. pp. 311–342; Pl. XLV.–XLVIII. 1877.

reached on either side ; the three following interspaces contain two denticles ; the wider space between the outer spine on either side and the lateral tooth gives room for four denticles. Thus we have thirty-nine denticles in all, in place of about one hundred in the stage described by Smith as the second. There is no vestige of appendages upon any of the abdominal segments.

The first pair of antennæ (Plate I. Fig. 8) are nearly as in the earliest stage as described by Smith ; but in some specimens I detected the rudiment of the secondary flagellum in the shape of a small tubercle at their base (*a*). On this point, however, there may be some doubt, as the secondary piece does not appear, according to Mr. Smith's observations, until the megalopa-stage is reached.

In the second pair of antennæ (Plate I. Fig. 9) the rounded prominence which represents the rudimentary flagellum in the "second" stage of the zoëa is so slightly developed as to be scarcely discernible (*c*).

The labrum (Plate I. Fig. 6 *a*) is enormously developed, and seems to be almost prehensile when one watches the motions of the living animal. The oral appendages and the first and second pairs of maxillipeds (natatory legs) (Plate I. Figs. 5, 6, 10 – 12) are similar in structure to those of the youngest stage observed by Professor Smith ; the outer lobe of the first pair of maxillæ (Plate I. Fig. 11 *b*), however, has but two slender teeth instead of three, as in the later stage, and the outer branches of the natatory legs (Plate I. Figs. 5, 6) bear four long plumose setæ instead of eight. Other differences will be most readily seen by comparing my figures with Professor Smith's. There is no trace of any appendages back of the second maxillipeds.

Length, including the abdomen, about 1 mm.

The heart is plainly visible through the transparent carapace, on the dorsal side of the cephalo-thorax. It has the form of a large, irregular pentagon, lying within a lozenge-shaped pericardial sac, with which it is connected by six delicate threads. The pericardium itself is attached to the walls of the body by stronger ligaments.

The heart gives off three arteries. Of these, one proceeds from the anterior angle, in the median line of the body, in the shape of a large tube to the base of the rostrum, where it suddenly diminishes in volume, but persists as a very minute canal to the tip of the rostrum. At the base of the rostrum, just where the diminution of the median artery occurs, a large lateral tube is given off on each side, which convey the bulk of the blood from the median channel to the eye-stalks. These arteries, which might be appropriately termed the rostral and ophthalmic arteries, are together equivalent to the ophthalmic artery of the adult, the small terminal branches to the eyes in the adult being here found in the form of long and capacious vessels, in relation to the large size of the eyes and their distance apart in the larva.

From the posterior part of the heart, two arteries are given off in the middle line of the body. The upper one is small, extends backward through the abdomen on the dorsal side, and ends in the telson. The other has its origin at nearly the same point as the first, but plunges down to the lower face of

the body. Its further course was not determined. The two posterior vessels correspond to the superior abdominal and sternal arteries of the adult. I was unable to discover any vessels answering to the antennary and hepatic arteries of the adult.

After issuing from the ends of the arteries, the blood may be seen coursing through the cavities of the body back to the heart. Two of these currents are evident in the abdomen, one above, and the other below, the abdominal artery. The venous blood in the cephalo-thorax streams back from the head along the border of the carapace and upward to the heart. No traces of gills exist at this stage. The blood is aërated in a great measure, probably, through the thin walls of the carapace, currents of water being kept up, as in the gill-bearing adult, by the constant motion of the scaphognathite of the second pair of maxillæ.

The integument is nearly colorless and transparent, with a few blotches of bright red pigment. The largest of the pigment-spots are, one on the lower side just back of the mouth, two on the carapace at the points where the lateral spines subsequently appear, and two on the telson (one on either side of the anal opening). Beside these there are a few smaller specks of pigment on the carapace and on the second, third, and fourth segments of the abdomen.

It will be seen, from the foregoing description and from the figures, that we have the same stage of the larva as that noticed by Fritz Müller on the coast of Brazil in the case of *Hippa emerita.* Of this a brief notice and an unsatisfactory figure are given in his work "Für Darwin." * Up to the time of Smith's observations this was all there was known of the developmental history of *Hippa.* The notice is very brief: "The zoëa of the Tatuira [*Hippa emerita*] (Fig. 25) also appears to differ but little from those of the true crabs, which it likewise resembles in its mode of locomotion. The carapace possesses only a short, broad frontal process; the posterior margin of the tail is edged with numerous short setæ."

Professor Smith says: "Very nearly fully developed embryos, when removed from the egg, were found to possess all the normal articulated appendages of the fully formed zoëæ, but there was no appearance of lateral spines upon the carapax, and the rostrum was broad and obtuse. In this stage the embryo agrees almost perfectly with the figure of the zoëa of *Hippa emerita* from the coast of Brazil, given by Fritz Müller in his work entitled 'Für Darwin.' The difference between the embryo in this stage and the second zoëa-stage [i. e. the stage presumed to be the second] (Plate XLV. Fig. 1), in which the rostrum and lateral spines are enormously developed, suggests the possibility that Müller had observed only imperfectly developed young zoëæ in which the rostrum and lateral spines were not expanded. It seems scarcely probable that such a difference could exist between the first stage of the zoëa, when the veiling membrane, in which, on first escaping from the egg, the

* Für Darwin. 1864. English Translation by W. S. Dallas, pp. 53, 54; Fig. 25. 1869.

young are usually enveloped, has been entirely cast off, and the lateral spines and the rostrum are fully expanded, and the second zoëa-stage about to be described." *

As I have now shown that the first stage is really devoid of lateral spines, and has only a short and broad rostrum, it is to be inferred that the so-called "second zoëa-stage" (which was taken in the towing-net) is in reality a later one in the development.† I was unable, with the greatest care, to rear any larvæ through the first moult into the second stage, but I think that one if not more stages remain to be discovered between the first and the earliest described by Smith.

II. Porcellana (Polyonyx) macrocheles.

Among the interesting Crustacean larvæ which the Gulf Stream bears to the southern shores of New England from more southern latitudes, is the peculiar zoëa of *Porcellana macrocheles.* Not uncommon on the coast of the Carolinas, the adult has been found but once, as far as I know, on the coast of New England, Mr. Alexander Agassiz having detected it under stones on the shore at Newport, R. I. In the same category are the young of *Calappa marmorata* and *Ocypoda arenaria*, which are found, the former rarely, the latter quite commonly, as far north as Cape Cod, but which rarely, if ever, survive our rigorous winter.‡

* *Op. cit.*, pp. 314, 315.

† Professor Smith's "numerous attempts to obtain newly hatched young, by keeping egg-carrying females in aquaria, failed from the parent's invariably casting off the eggs before they were fully matured." (*Op. cit.*, p. 314.) By selecting females with eggs considerably advanced toward maturity, and placing them in a cool place, in shallow vessels covered at the bottom with clean sand, and renewing the water twice a day *directly from the sea*, I found no difficulty in obtaining several broods of young at various times between the 1st and 30th of August. I succeeded best by covering the sand with but a slight depth of water, and tipping up the vessel a little so that part of the sand was above water, thus imitating the natural beach, where at low tide the *Hippæ* are found in the wet sand just above the water-mark. I observed that in vessels so placed the *Hippæ* for a large part of the time preferred the wet sand above the water-line.

For the free use of the laboratory and apparatus of the United States Fish Commission at Wood's Hole, in the summer of 1877, I am indebted to Professor S. F. Baird, U. S. Commissioner of Fish and Fisheries.

‡ Professor S. I. Smith found small, young specimens of *Ocypoda arenaria* in the latter part of August and in September on Fire Island Beach, Long Island, but careful search failed to reveal a single specimen of the adult or half-grown crab. (Amer. Jour. Sci. and Arts, 3d Series, VI. p. 68. 1873. Invert. Animals of Vineyard Sound, p. 241. 1873.) No one has found the zoëa of this animal so far north, although the megalopa is not uncommon. The zoëæ of *Porcellana* which I collected at Newport were nearly all in the last stage of their development. From these facts it is highly probable that these species are not *natives* of the New England coast.

On several warm, still mornings in August, 1878, the zoëæ of *Porcellana* swarmed in the streaks of smooth water on the edge of the tidal currents at the mouth of Narragansett Bay.* They are sluggish, and move either forward or backward. The little spines with which their enormously developed rostra are armed serve to accumulate the minute particles floating in the water to such an extent that the little creatures often become quite conspicuous by virtue of the load of dirt which they carry.

Of the numerous specimens which I collected almost all were in the stage immediately preceding the youngest stage of the crab, into which they readily developed in confinement, and some of which were taken from the sea with the zoëæ.

Specimens in the last zoëa-stage (Pl. II. Fig. 1) measure about 16 mm. from the tip of the rostrum to the tips of the posterior spines of the carapace. The rostrum is 11 mm. long, the posterior spines 2.5 mm.

Viewed from the side, the carapace is of a long oval form, extending forward as an enormous rostrum, and backward into two horns curved slightly downward at their ends. The rostrum is furnished with five rows of little spines disposed as shown in the cross-section (Pl. II. Fig. 3). The posterior horns have a single row of spines below (Pl. II. Figs. 2, 4). The first pair of antennæ (Pl. II. Fig. 6) are composed of a long peduncle which is obscurely divided into two or three segments. At its base there is a slight enlargement which contains the auditory apparatus (*a*). The peduncle bears a blunt process (*b*), and a longer segment (*c*) which is furnished with several sensory threads (*d*). The second pair of antennæ consist of a two-jointed peduncle, in the basal segment of which may be seen the orifice of the renal organ (*c*). Of the two branches borne by the peduncle, the inner (*a*) is the longer, and within its transparent integument is seen the multi-articulate flagellum of the antenna of the crab, to be disclosed at the next moult. The outer branch (*b*) is styliform. The mandibles have a many-toothed crown (Pl. II. Fig. 8), and the palpus is represented by a very small protuberance (*a*).† The bilobed metastoma is armed with short setæ on the inner margin of each lobe (Pl. II. Fig. 9). The first pair of maxillæ consist of an inner lobe (Pl. II. Fig. 10 *a*) and

* I am indebted to Mr. Agassiz for the facilities for investigation afforded by his laboratory at Newport, R. I.

† Although this is certainly the last stage of the zoëa (I obtained the young crab from it after a single cast of the skin), the mandibular palpus is not developed to anything like the extent seen in Dohrn's figure of a *Porcellana* zoëa. (Untersuchungen über Bau und Entwicklung der Arthropoden. Zeits. Wiss. Zool. XXI. p. 373; Taf. XXIX. Fig. 51. 1871.) Claus, describing a *Porcellana* zoëa from Nice in a stage corresponding to the one before us (Marburger Sitzungsberichte, 1867, p. 15), states that the mandibles are destitute of palpi; but in his later work, "Untersuchungen zur Erforschung der Genealogischen Grundlage des Crustaceen-Systems," 1876 (p. 58), describing the same stage, he says the rudiment of the palpus exists as a simple prominence.

an outer lobe (*b*) ; the outer lobe bears the palpus (*c*). All the parts which compose the first maxilla are furnished with plumose setæ. The second pair of maxillæ (Pl. II. Fig. 11) consist of four lobes of about equal size, a narrower lobe, and a scaphognathite (*a*) ; all of these lobes are fringed with plumose setæ on their margins.

The two pairs of swimming-feet (first and second maxillipeds) (Pl. II. Fig. 1) are very similar to each other in form. The outer branch is two-jointed, the inner branch four-jointed. The third pair of maxillipeds (Pl. II. Figs. 1, 12) are rudimentary, sac-like structures, which can hardly as yet be of much functional value. They are, however, developed so far as to project beyond the border of the carapace. The inner branch (Fig. 12 *a*) is much longer than the outer (*b*). The latter is tipped with long setæ. Through the transparent sac-like integument the segments of the outer maxilliped of the next stage may be indistinctly seen.

The five pairs of ambulatory limbs of the future crab are doubled up under the carapace (Pl. II. Fig. 1). By removing them from the body of the zoëa their whole form is seen as represented in Pl. II. Fig. 13. Through the thin investing membrane the segmentation of the limbs is quite distinctly seen as it exists in the following stage after the tegument has been thrown off. Even the hooks on the last segment of the second, third, and fourth pairs are visible (*b′*). At the base of the thoracic appendages the gills (six pairs) have already attained a considerable size (Figs. 1, 13 *f*).

The abdomen is composed of six segments. The telson (Pl. II. Fig. 5) is produced on either side into a strong tooth ; the posterior margin is very convex, scalloped, and ornamented with twelve beautiful, feather-like setæ. In specimens about to moult the telson is seen to contain the sixth abdominal segment (*b*) with its appendages (*c*, *d*), as well as the telson (*a*) of the crab. There is a pair of simple unsegmented appendages on the second, third, fourth, and fifth segments of the abdomen (Pl. II. Figs. 1, 14).

The stomach shows through the transparent carapace just back of the base of the rostrum. On either side are four lobes of the liver, two directed forward, two backward. The intestine is straight and simple, and ends in the fore part of the telson below. The heart lies under the centre of the carapace ; from its anterior angle the median artery can be traced nearly to the end of the rostrum ; the sternal artery reaches the lower floor of the thorax near the roots of the third pair of maxillipeds, passing through the great thoracic nerve-mass ; here it forks, one branch proceeding forward, giving off in its course lateral branches to the anterior appendages, the other backward to the abdomen.

The nervous system departs widely from its primitive condition even in this immature stage. The thoracic ganglia are consolidated into an enormous mass which sends nerves to the thoracic appendages. From this thoracic nerve-mass two parallel nerve-cords extend through the abdomen, binding together the ganglia, which lie one in each abdominal segment.

The integument is nearly colorless, with some spots of vermilion pigment on the basal segments of the first and second pairs of maxillipeds, on the tel-

son, and on the lower side of the cephalo-thorax. There is also vermilion in the wall of the intestine.

A few specimens were collected in a younger stage than that described above. They were somewhat smaller than the other specimens ; the first pair of antennæ were simple, with three or four sensory threads at the tip ; the Decapodal legs were very small buds, much more rudimentary than in the later stage ; the third pair of maxillipeds were also smaller, with the inner branch much shorter in proportion to the outer branch ; the four pairs of abdominal limbs were present, but of smaller dimensions ; the telson displayed but ten plumose setæ on its posterior margin. In other respects they agreed pretty closely with the older individuals.

Many of the specimens in my aquaria developed from the oldest zoëa-stage directly into the first stage of the crab (Plate III. Fig. 1), described further on, in which there is not the slightest trace left of the rostrum or posterior spines of the zoëa. In one instance I detected the young crab in the very act of disengaging itself from its zoëa-case. In another young crab which had just emerged from the zoëa, the shrivelled remnant of the artery and other soft parts within the rostrum of the zoëa was still sticking to its front.

Fritz Müller was right, then, when he surmised that the oldest *Porcellana* zoëa observed by him at Santa Catharina (which was in the same stage as the oldest zoëa described above) would pass through the next moult into a form not differing essentially from the adult *Porcellana*,* although Claus thinks it probable that there is an intervening form corresponding to the youngest megalopa-stage of the *Brachyura*.†

First Porcellana-*stage* (Plate III. Figs. 1 – 10). The carapace is now about 2 mm. long ; its breadth is about the same as its length. It is suborbicular in its outline, the front broad and furnished with minute hairs.

* Die Verwandlung der Porcellanen. Arch. f. Naturgeschichte, 1862, 1, p. 198.

† After describing the same stage as the oldest one observed by Müller, Claus says: "Ueber die späteren Entwicklungsstadien fehlen mir leider Beobachtungen, doch wird es nach Analogie mit der Krabbenmetamorphose wahrscheinlich, dass sich noch ein Zwischenglied, etwa dem jüngsten Megalopastadium entsprechend, einschiebt. *Fr. Müller* bemerkt zwar, dass das mit der nächsten Häutung hervorgehende Thier kaum wesentlich von der erwachsenen *Porcellana* verschieden sei, da die Porcellanen auf die Stufe der *Megalopa* stehen geblieben sind. Indess ist dabei zu bemerken, dass es sich hier um das Endglied der Megalopaformen handelt, zu welchem auch bei den Krabben die Zoëa nicht unmittelbar, sondern durch Zwischenformen führt." (Untersuchungen, p. 59.) In reality, one sees in the young *Porcellana* no zoëa-characters persisting in the shape of large eyes, form and armature of the carapace, such as are found in the youngest stages of megalopæ. In these regards it is as far removed from the youngest megalopa-stage as the adult is. The abdomen, moreover, is relatively no larger than in the mature animal, and, as far as I observed, but little used as a swimming-organ. True, the abdomen is furnished with two-branched setiferous appendages (Pl. III. Fig. 10), but this is not a peculiarity of the youngest megalopa-stage of *Brachyura* ; as will be seen further on in *Pinnixa*, like appendages are retained (in both sexes, apparently), even in the youngest crab-stages.

The abdomen is relatively no larger than in adult specimens, and is bent underneath against the sternum. The telson consists of a single piece, with a faint indication of the median suture of the adult. After the next moult the diagonal sutures appear (Fig. 8) and the telson assumes the polymeric character of the adult.* The posterior border of the telson is fringed with long and delicate setæ.

The first pair of antennæ (Figs. 3, 6 *b*) have an enormously developed basal (auditory) segment (Fig. 3 *a*), followed by a three-jointed peduncle bearing two flagella (*b*, *c*), of which the outer (*c*) is the longer.

The second pair of antennæ are very long (longer than in the adult), composed of about thirty-four segments.

The oral appendages have almost exactly the structure of the corresponding appendages of the adult, which are represented on Plate III. Figs. 13 – 18. The mandibular palpus has attained its perfect, tri-articulate structure, and is as large in relation to the size of the body of the mandible as it is in the full-grown specimens. This is remarkable when one considers its rudimentary form in the last zoëa-stage (Plate II. Fig. 8 *a*).

The chelipeds are longer than in the adult (Fig. 11). One (commonly the right) is larger than its fellow. Like the four following pairs of thoracic legs, they are beset with setæ on either border.

The ambulatory pairs are also longer than in the adult. The dactylus (Fig. 4) is armed with hooks like those in the full-grown specimens (Fig. 19), but it is much more slender.

The posterior thoracic legs are rudimentary and terminated with a didactyle claw (Fig. 5), as perfectly formed as in the adult.

The second, third, fourth, and fifth abdominal segments bear peculiar two-branched appendages (Fig. 10), furnished with long, feather-like setæ. The large number of individuals which I examined (which it is fair to presume included both sexes) showed no difference in the number and shape of the appendages of the abdomen. In the adult these appendages take on a very different form in both sexes. In the female they become one-branched, slender organs (Fig. 20), and the pair belonging to the second segment disappears.† In the male only one pair persists (on the second segment, Fig. 21) ; here the second branch exists as a rudiment (*a*). The series of changes through which the abdominal appendages of the young are converted into the adult form I was unhappily unable to follow. In specimens from South Carolina, 6 mm. across the carapace, the external sexual characters are already acquired.

My specimens underwent but little change, before I left Newport in Septem-

* Milne Edwards thought that the sutures in the telson of *Porcellana* showed that it was formed by a consolidation of the seventh abdominal segment with a pair of appendages belonging to the same segment (Histoire Naturelle des Crustacés, II. p. 249. 1837). It is plain from the development that this theory of the structure of the telson is false.

† In the adult females of many species of *Porcellana* the first, second, and *third* abdominal segments are destitute of appendages.

ber. Several individuals moulted once or twice, but beyond a slight increase in size, a growing opacity of the shell, and the change in the telson noticed above, little alteration was discernible.

On looking at the proportions of the adult *Porcellana macrocheles* (Fig. 11; the carapace of this specimen measured 9 mm. in length by 12.5 mm. in width) one might be inclined to doubt its identity with our young form; but I have material at hand to show that the widening of the carapace is the gradual result of growth. In a specimen 3.5 mm. broad, caught, free-swimming, at Newport on the 30th August, 1865, by Mr. Alexander Agassiz,* of which he made a sketch at the time, the breadth of the carapace exceeds its length by one fifth. In a specimen from Charleston, S. C., 6 mm. broad, the carapace is less than one fourth broader than long.

As the delicate integument of the young becomes indurated by the deposition of calcareous salts, and the aëration of the blood devolves more and more exclusively upon the gills, the carapace broadens with the expansion of the respiratory chamber. This change in the proportions of the carapace is commonly seen in the *Brachyura* when a graduated series from very small to adult specimens is examined, and Carcinologists cannot be warned too often against establishing new species upon juvenile characters.

List of Works relating to the Development of Porcellana.

HAILSTONE and WESTWOOD. Descriptions of some Species of Crustaceous Animals. By S. HAILSTONE, JUN., ESQ. With Illustrations and Remarks, by J. O. WESTWOOD, ESQ., F. L. S., etc. Loudon's Magazine of Natural History, Vol. VIII. pp. 261 – 277; Figs. 28, 29, May, 1835.

This paper contains descriptions and figures of a series of young specimens of *Porcellanæ* from Hastings, England (*P. minuta* Westw.; probably the young of *P. longicornis*, M. Edw.). The smallest of these specimens measured 2 mm. in length, and was used by Westwood as an argument against the probability of a metamorphosis in *Porcellana*, which had recently been announced by J. V. Thompson.

THOMPSON, J. V. Memoir on the Metamorphosis in *Porcellana* and *Portunus*. Entomological Magazine, Vol. III. pp. 275 – 277, Fig. 1, Oct. 1835.

This is the first published notice of the zoëa of *Porcellana*.† Thompson actually

* Mr. Agassiz has another drawing of a young *Porcellana* raised from the zoëa at Newport, August 17, 1875, which seems to indicate the occurrence of a second species on the coast of New England. In this form the front is prominent and triangular, the dactyli of the ambulatory feet long and without the accessory claws of *Polyonyx*. The length of the carapace is 3 mm., its breadth slightly less.

† According to Claus, who ignores the observations of Thompson, Couch, and Dujardin (Marburger Sitzungsberichte, 1867, p. 12; Untersuchungen über Crustaceen, p. 57), the larva of *Porcellana* was described under the name of *Lonchophorus anceps* as early as 1825 by Eschscholtz. (Bericht über die zoologische Ausbeute während der Reise von Kronstadt bis St. Peter- und Paul. Isis von Oken. 1825, 1, col. 734; Taf. V. Fig. 1.) The animal here referred to, as is evident from the figure, is the Brachyuran zoëa afterwards described by Dohrn (Zeits. Wiss. Zool. XXI.

obtained the larvæ of one of the British species from the eggs, and gives a rude figure of the first stage of the zoëa.

COUCH, R. Q. "On the Metamorphosis of the Decapod Crustaceans. Ann. Rep. and Trans. Cornwall Polytechnic Society, 1843."

An account of Couch's observations (I have not been able to see the original paper) is given in Bell's "History of the British Stalk-eyed Crustacea," Introduction, pp. lv–lvii, Figs. *f*, *g*, *h*. 1853. Couch reared the larvæ of *Porcellana platycheles* from the egg, but it is difficult to understand his confused account and figures as reproduced by Bell. It appears as if Fig. *f*, which is said to represent the larva on its first escape from the egg, must represent one prematurely extracted from the egg while still clad in the intra-oval veiling membrane, with the rostrum folded under the breast.

DUJARDIN, FÉLIX. Observations sur les métamorphoses de la *Porcellana longicornis*, et description de la *Zoé*, qui est la larve de ce crustacé. Comptes Rendus, XVI. pp. 1204–1207. 1843.

First stage of zoëa, obtained from the eggs. *The horns of the carapace are described as segmented.*

DANA, J. D. United States Exploring Expedition. Crustacea. Pp. 684, 685. Pl. 45, Fig. 12. 1852.

Dana's *Zoëa longispina*, taken in the Sooloo Sea, Feb., 1842, is doubtless the larva of a *Porcellana*.

MÜLLER, FRITZ. Die Verwandlung der Porcellanen. Archiv für Naturgeschichte, 1862, 1, pp. 194–199; Taf. VII.

Für Darwin, 1864. (Eng. Trans. p. 53, Fig. 24. 1869.)

Müller observed the zoëæ of three species at Desterro, Brazil, in two stages of development. His first stage, with simple first antennæ and lack of appendages back of the second maxillipeds, is probably the earliest stage of the zoëa after quitting the egg. The second form is doubtless the last zoëa-stage, as Müller himself suspected, although he did not rear it into the *Porcellana*. Müller did not fail to see the Brachyuran character of the development of *Porcellana*.

CLAUS, CARL. Ueber den Entwicklungsmodus der Porcellana-Larven im Vergleiche zu den Larven von Pagurus. Sitzungsberichte der Gesellschaft zur Beförderung der gesammten Naturwissenschaften zu Marburg. 1867, pp. 12–16.

Untersuchungen zur Erforschung der Genealogischen Grundlage des Crustaceen-Systems, pp. 57–59; Taf. VII. Figs. 1–13. 1876.

Describes zoëæ from the Mediterranean Sea and the Atlantic Ocean in three developmental stages. In the second of these stages the first antennæ are still unsegmented, the third maxilliped and the five pairs of ambulatory limbs exist in the shape of six pairs of short sacs. This is apparently a younger stage than the earliest observed by me, in which the abdominal legs have already appeared. Claus' first and third stages are the earliest and last zoëa-stages (see above, p. 259).

DOHRN, ANT. Untersuchungen über Bau und Entwicklung der Arthropoden. 11. Zweiter Beitrag zur Kenntniss der Malacostraken und ihrer Larvenformen. Zeits. Wiss. Zool. XXI. pp. 372, 373; Taf. XXIX. Figs. 48–51. 1871.

p. 373; Taf. XXX. Fig. 52, 1871), and by Claus himself under the name of *Pluteocaris* (Untersuchungen über Crustaceen, p. 65; Taf. XII. Figs. 1–7)! Claus' reference, moreover, is incorrectly "Froriep's Notizen" instead of "Isis."

III. Pinnixa.

As long ago as 1835 the zoëa of *Pinnotheres* was raised from the egg and figured by J. V. Thompson.* Although this was one of the earliest known cases of metamorphosis among the *Crustacea*, Thompson's memoir has remained the sole contribution to the developmental history of the *Pinnotheridæ* up to the present time.

In the latter part of August, 1878, a large zoëa was not uncommon in Narragansett Bay, which developed in the aquarium into a species of *Pinnixa*. The development of this species is remarkable for the complete suppression of the megalopa-stage, the zoëa figured on Plate IV. (Figs. 5-15) passing directly into the first stage of the crab, represented on Plate V.

In the last zoëa-stage (Plate IV. Figs. 5-15) the carapace is armed with long frontal, dorsal, and lateral spines. The natatory feet are very short in proportion to the size of the body, the inner branch of the second pair (Fig. 11, *a*) rudimentary, as usual with Brachyuran zoëæ. The third pair of maxillipeds and the five following pairs of thoracic feet are folded under the carapace. On dissecting them out from the body, they are seen to be quite perfectly formed, as shown by Fig. 7. The third maxillipeds (Fig. 8) possess their three constituent parts (*a*, *b*, *c*) and a gill (*d*) at their base.

The abdomen (Fig. 10) is short, its penultimate segment expanded laterally into two lobes, which extend backward on each side of the terminal segment.† The terminal segment is ovate, produced posteriorly into a long spine on either side. Between the lateral spines and a small median sinus are three short, finely feathered setæ on either side.

There are four pairs of simple abdominal appendages.

There is a black pigment spot at the base of the dorsal spine, one near the base of each of the lateral spines, and several on the abdominal somites.

From tip of frontal spine to posterior border of carapace, 2.5 mm. From tip to tip of lateral spines, 2 mm. Length of frontal spine, 1 mm.

In the first crab-stage (Plate V.), which immediately follows the last zoëa-stage just described, the carapace measures less than 1 mm. in length by 1.5 mm.

* Memoir on the Metamorphosis and Natural History of the *Pinnotheres* or Pea-Crabs. By W. [J. V.] Thompson, F. L. S. Entomological Magazine, Vol. III. pp. 85-90. Figs. 1, 2. April, 1835.

† This peculiarity is also seen in the undetermined zoëa, figured by Claus, "Untersuchungen," etc. Taf. XIV. Figs. 1, 2 (p. 65). The abdomen of the zoëa of *Pinnotheres pisum* apparently has a like form, judging from Thompson's rude figures (*l. c.*), in which the penultimate and ultimate segments are represented as a single piece.

In "Für Darwin" Fritz Müller figures the tail of a *Pinnotheres* (Fig. 19). It has the shape generally seen in Brachyuran zoëæ, while Fig. 22, "of unknown origin," represents a tail like that of *Pinnixa* and Thompson's *Pinnotheres*. Is there no confusion here?

in breadth. The front is nearly straight, the branchial regions expanded laterally so as to form a prominent shoulder at the point where they meet the hepatic areas. A row of small, irregularly disposed spines on the sides of the carapace. The second and third pairs of maxillipeds (Figs. 6, 7) have the same structure as in adult *Pinnixæ*, the terminal segment of the inner limb being articulated with the penultimate segment near the proximal end of the latter, in such a fashion as to form a sort of didactyle claw.

The chelæ are didactyle, the dactylus closing against a long process of the antecedent segment. The following pairs of ambulatory appendages are extremely long, the last pair being much smaller than the rest, as in the adults of this genus.

The abdomen is small, closely folded against the sternum, and not used as a swimming organ. It carries four pairs of appendages (Fig. 3), which consist of a basal segment which supports two branches. The outer branch is much larger than the inner, and bears about nine setæ on its border. The telson is broader than long, its posterior margin regularly convex and fringed with setæ.

Blotches of dark pigment, of dendritic forms, occur on the carapace, sternum, and abdomen, arranged as represented in Figs. 1, 2.

The young crabs underwent hardly any change during my stay at Newport, and it is impossible to determine to which of the several species of *Pinnixa*, described from the eastern coast of the United States, these immature specimens belong. According to Smith, the only species found on the New England coast is *Pinnixa cylindrica* White.* I found no adult specimens at Newport.

Since the above account was prepared, I have received, through the courtesy of Professor Smith, a pair of adult *Pinnixæ* from Buzzard's Bay, Massachusetts, and a few zoëæ "hatched at Noank, Connecticut, August 3, 1874, from eggs of a specimen apparently exactly like the adults sent." I identify the adults with *Pinnixa chætopterana* Stimpson † (Plate V. Fig. 8, chela of male; Fig. 9, chela of female). The zoëæ (Plate IV. Figs. 1–4) are less than a millimeter in length. The spines of the carapace are proportionately shorter than in the older zoëa described above, the swimming-feet and abdomen longer. The appendages back of the second pair of maxillipeds are wanting. The abdomen is very like the abdomen in the older zoëa, but has a small, triangular, terminal piece (Fig 2 *b*) between the setæ of the telson.

Professor Smith informs me that he observed, in 1875, the direct change

* Report upon the Invertebrate Animals of Vineyard Sound and Adjacent Waters, with an Account of the Physical Features of the Region. By A. E. Verrill and S. I. Smith. In Baird's Report on the Condition of the Sea-Fisheries of the South Coast of New England in 1871 and 1872, p. 546. 1873.

† Notes on North American *Crustacea* in the Museum of the Smithsonian Institution. No. II. Ann. Lyc. Nat. Hist. N. Y. Vol. VII. p. 235. 1862.

from the zoëa to the crab in the species described in this paper, and that he had, besides, another zoëa, apparently distinguished from mine only by its slightly smaller size and shorter spines, which passed into a megalopa phase! In this stage (a tracing of which is enclosed in Professor Smith's letter) the carapace is broad and crab-like, without a vestige of the spines of the zoëa. This megalopa subsequently changed into a young crab very nearly like that which developed *immediately* from the long-spined zoëa.*

It would seem, therefore, that two species of *Pinnixa* occur, at least in the young stages, on the southern shore of New England, which present a remarkable difference in their development. While the one goes through the customary megalopa condition, the other passes, by a syncopated development, from the zoëa directly into the brachyurous state.

CAMBRIDGE, January, 1879.

EXPLANATION OF THE PLATES.

NOTE. I am greatly indebted to my brother, Mr. Charles E. Faxon, for preparing my drawings for the heliotypic process.

PLATE I. **Hippa talpoida.**

Fig. 1. Cluster of segmented eggs taken from the abdominal appendages of a female. The eggs are spherical, about 1.5 mm. in diameter, of a bright orange-yellow color.

Fig. 2. Egg with the enclosed embryo in the "nauplius-stage": *a*, labrum; *b*, antenna of the first pair; *c*, antenna of the second pair; *d*, mandible; *e*, abdomen; *f*, yelk.

Fig. 3. Embryo further advanced: *a*, rostrum; *b*, cephalic plate; *c*, antenna of first pair; *d*, antenna of second pair; *e*, mandible; *f*, first maxilla; *g*, second maxilla; *h*, first maxilliped; *i*, second maxilliped (even at this early stage, the appendages back of the mandible are double); *k*, abdomen (the likeness of the abdomen in this embryonic stage to the abdomen of prawn-zoëæ is suggestive).

Fig. 4. The same, from a different point of view: *a*, antenna of first pair; *b*, antenna of second pair; *c*, mandible; *d*, first maxilla; *e*, second maxilla; *f*, first maxilliped; *g*, second maxilliped; *h*, hind border of carapace.

* Professor Smith has also kindly sent me tracings of the zoëa of *Pinnotheres maculatus* raised from eggs. It has a long dorsal spine (wholly wanting in Thompson's figures of the zoëa of *Pinnotheres pisum*), and the abdomen is like that figured by Fritz Müller as *Pinnotheres*, "Für Darwin," Fig. 19 (*v. supra*, p. 263, note †). Altogether the zoëa bears less resemblance to the zoëa of *Pinnotheres pisum*, as represented by Thompson, than the zoëa of *Pinnixa* does! It should be noted that the accuracy of Thompson's figures is attested by Bell ("British Stalk-eyed Crustacea," p. 125).

Fig. 5. First zoëa-stage.

Fig. 6. The same, viewed from below : *a*, labrum ; *b*, process of the carapace extending forward under the eyes ; *c*, mandible ; *d*, metastoma ; *e*, first maxilla ; *f*, outer branch of first maxilliped ; *g*, inner branch of first maxilliped ; *h*, outer branch of second maxilliped ; *i*, inner branch of second maxilliped ; *k*, anus ; *l*, telson.

Fig. 7. Eye-stalk and eye of the same stage.

Fig. 8. First antenna of the same : *a*, rudiment of the secondary flagellum ?

Fig. 9. Second antenna of the same : *a*, *b*, dentiform processes ; *c*, rudiment of the future flagellum.

Fig. 10. Mandible.

Fig. 11. First maxilla : *a*, inner lobe ; *b*, outer lobe ; *c*, palpus.

Fig. 12. Second maxilla : *a*, inner lobe ; *b*, scaphognathite.

Fig. 13. Posterior border of the telson ($\frac{1}{5}$ in. obj.). The arrow indicates the median line of the telson.

Fig. 14. A spine and two adjacent denticles of the same, more highly magnified ($\frac{1}{10}$ in. obj.).

Fig. 15. Posterior part of the carapace, viewed from behind and below : *a*, thickening of the integument at the point where the lateral spines appear in later stages of the zoëa ; *b*, abdominal sinus.

PLATE II. **Porcellana (Polyonyx) macrocheles.**

Last zoëa-stage.

Fig. 1. Lateral view of the zoëa.

Fig. 2. Posterior portion of the carapace from below.

Fig. 3. Cross-section of the rostrum.

Fig. 4. Cross-section of one of the posterior horns of the carapace.

Fig. 5. Telson : *a*, the antecedent abdominal segment ; *b*, the sixth abdominal segment of the next stage, showing through the integument of the zoëa ; *c*, *d*, *e*, the inner and outer branches of the last abdominal appendages and the telson of the next stage showing through the telson of the zoëa.

Fig. 6. First antenna : *a*, swelling at the base for the lodgment of the auditory organ ; *b*, inner branch ; *c*, outer branch ; *d*, sensory hairs on the outer branch.

Fig. 7. Second antenna : *a*, internal branch (the annuli of the flagellum of the antenna of the next stage are seen within) ; *b*, external branch ; *c*, outlet of the "green gland."

Fig. 8. Mandible : *a*, rudiment of the palpus.

Fig. 9. Metastoma.

Fig. 10. First maxilla : *a*, inner lobe ; *b*, outer lobe ; *c*, palpus.

Fig. 11. Second maxilla : *a*, scaphognathite.

Fig. 12. Third maxilliped : *a*, internal branch ; *b*, external branch.

Fig. 13. The five following pairs of appendages (Decapodal legs) as they appear when removed from under the carapace of the zoëa : *a*, cheliped ; *b*, *c*, *d*, *e*, ambulatory pairs ; *f*, gills. The chelæ of the first and fifth pairs

and the hooks on the terminal segment of the intervening three pairs (from which the genus *Polyonyx* takes its name) are seen through the outer, investing membrane.

Fig. 14. One of the abdominal appendages : *a*, the appendage to be disclosed at the next moult.

PLATE III. **Porcellana (Polyonyx) macrocheles.**

Figs. 1 – 10. First stage of the crab.

Fig. 2. One of the minute hairs of the front, highly magnified.

Fig. 3. First antenna : *a*, basal (auditory) segment ; *b*, inner branch ; *c*, outer branch.

Fig. 4. Terminal segment of one of the ambulatory limbs.

Fig. 5. Chela of the last thoracic appendage.

Fig. 6. View from the front : *a*, eye ; *b*, first antenna ; *c*, second antenna ; *d*, carapace ; *e*, basal segment of cheliped.

Fig. 7. Abdomen.

Fig. 8. Telson, after the first moult.

Fig. 9. Third maxilliped : *a*, inner branch ; *b*, outer branch ; *c*, gill.

Fig. 10. Appendage of fifth abdominal segment, right side from beneath : *a*, inner branch ; *b*, outer branch. Similar appendages are found on the second, third, and fourth abdominal segments.

Figs. 11 – 21. Adult specimen from South Carolina.

Fig. 12. First antenna of the right side, from below : *a*, basal (auditory) segment ; *b*, inner branch ; *c*, outer branch.

Fig. 13. Left mandible, seen from beneath : *a*, palpus.

Fig. 14. First maxilla of the left side, seen from beneath : *a*, inner lobe ; *b*, outer lobe ; *c*, palpus.

Fig. 15. Second maxilla of the left side, seen from beneath : *a*, scaphognathite.

Fig. 16. First maxilliped of the left side, seen from beneath.

Fig. 17. Second maxilliped of the left side, seen from beneath : *a*, inner branch ; *b*, outer branch.

Fig. 18. Third maxilliped of the left side, seen from beneath : *a*, inner branch ; *b*, outer branch.

Fig. 19. Terminal segment of one of the ambulatory limbs.

Fig. 20. Appendage of right side of third abdominal segment of female. A pair of similar appendages exists on the third and fourth abdominal segments.

Fig. 21. Appendage of second abdominal segment of the male : *a*, rudimentary second branch. In this sex there is only one pair besides the swimmerets of the sixth segment.

PLATE IV. **Pinnixa.**

Fig. 1. First stage of the zoëa of *Pinnixa chætopterana*, from Noank, Conn.

Fig. 2. Abdomen of the same : *a*, spine ; *b*, terminal piece of the telson.

Fig. 3. Second maxilliped of the same : *a*, inner branch ; *b*, outer branch.

Fig. 4. First maxilliped of the same : *a*, inner branch ; *b*, outer branch.

Figs. 5-15. Last stage of the zoëa of a *Pinnixa*, from Newport, R. I.

Fig. 5. Anterior view.

Fig. 6. Posterior view.

Fig. 7. Third maxilliped, cheliped, and ambulatory appendages of the future crab, removed from under the carapace of the zoëa : a', a'', a''', inner, middle, and outer branches of the third maxilliped ; *b*, cheliped ; *c*, *d*, *e*, *f*, ambulatory appendages ; *g*, gills.

Fig. 8. Third maxilliped : *a*, inner branch (endognathite) ; *b*, middle branch (exognathite) ; *c*, outer branch (epignathite) ; *d*, gill.

Fig. 9. Second maxilla : *a*, scaphognathite.

Fig. 10. Abdomen : *a*, *b*, *c*, *d*, first, second, third, and fourth pairs of abdominal appendages.

Fig. 11. Second maxilliped : *a*, inner branch ; *b*, outer branch.

Fig. 12. First maxilliped : *a*, inner branch ; *b*, outer branch.

Fig. 13. First maxilla : *a*, inner lobe ; *b*, outer lobe ; *c*, palpus.

Fig. 14. *a*, first antenna ; *b*, second antenna.

Fig. 15. Metastoma.

NOTE. Figs. 9 and 11-15 were drawn from the exuviæ of a zoëa which had changed into a crab.

PLATE V. **Pinnixa.**

Fig. 1. First crab-stage of a *Pinnixa*, from Newport, R. I. (developed at one moult from the zoëa represented on Plate IV. Figs. 5-15). Dorsal view.

Fig. 2. The same ; ventral view.

Fig. 3. The same ; abdomen viewed from beneath, with its appendages.

Fig. 4. The same ; first antenna.

Fig. 5. The same ; first maxilliped.

Fig. 6. The same ; second maxilliped : *a*, endognathite ; *b*, exognathite.

Fig. 7. The same ; third maxilliped : *a*, endognathite ; *b*, exognathite ; *c*, epignathite.

Fig. 8. Left chela of adult male *Pinnixa chætopterana* from Buzzard's Bay. The carapace of this specimen measures 4 mm. in length by 7.5 mm. in breadth.

Fig. 9. Right chela of a small adult female of the same. Carapace, 3 mm. × 5.5 mm.

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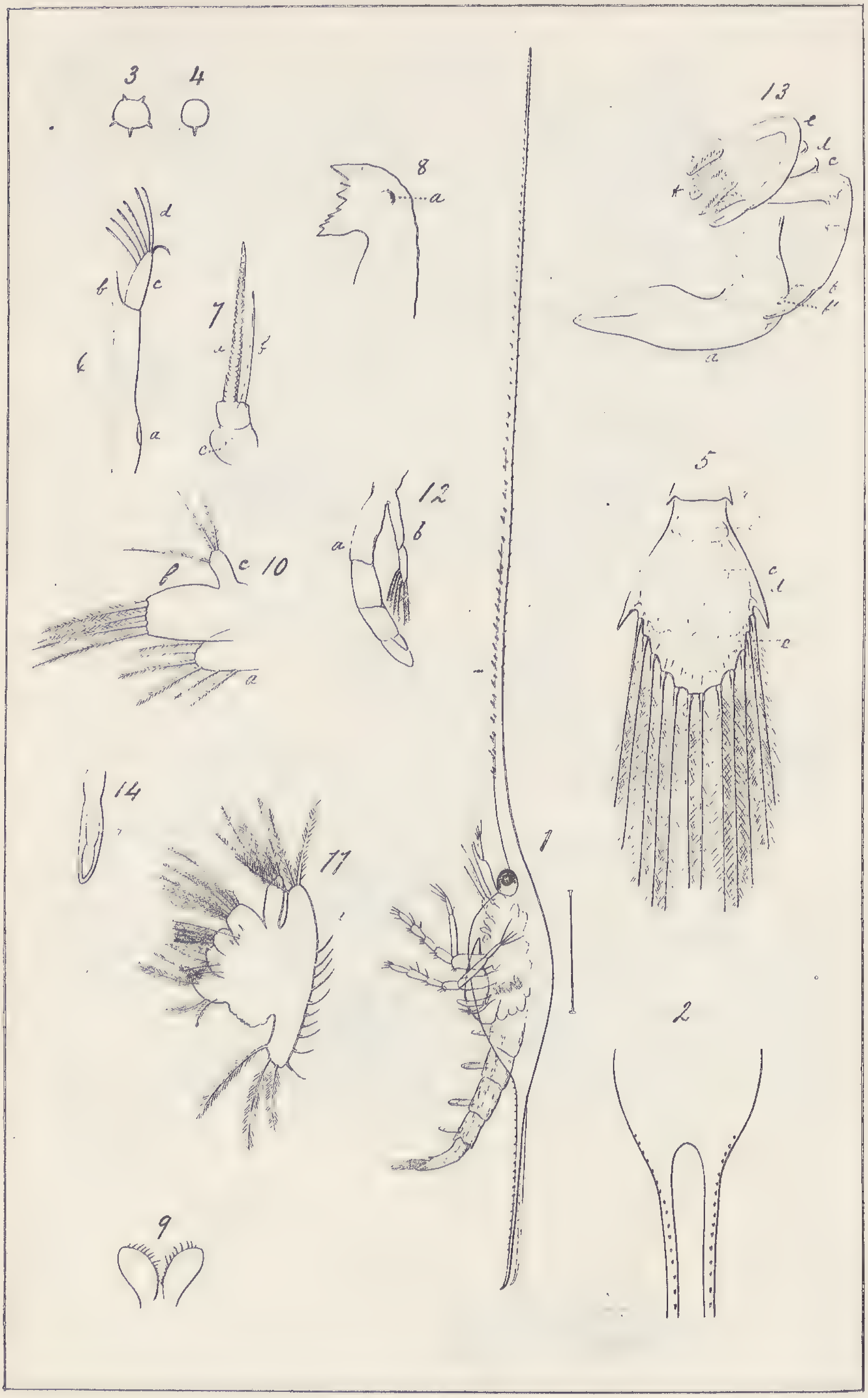

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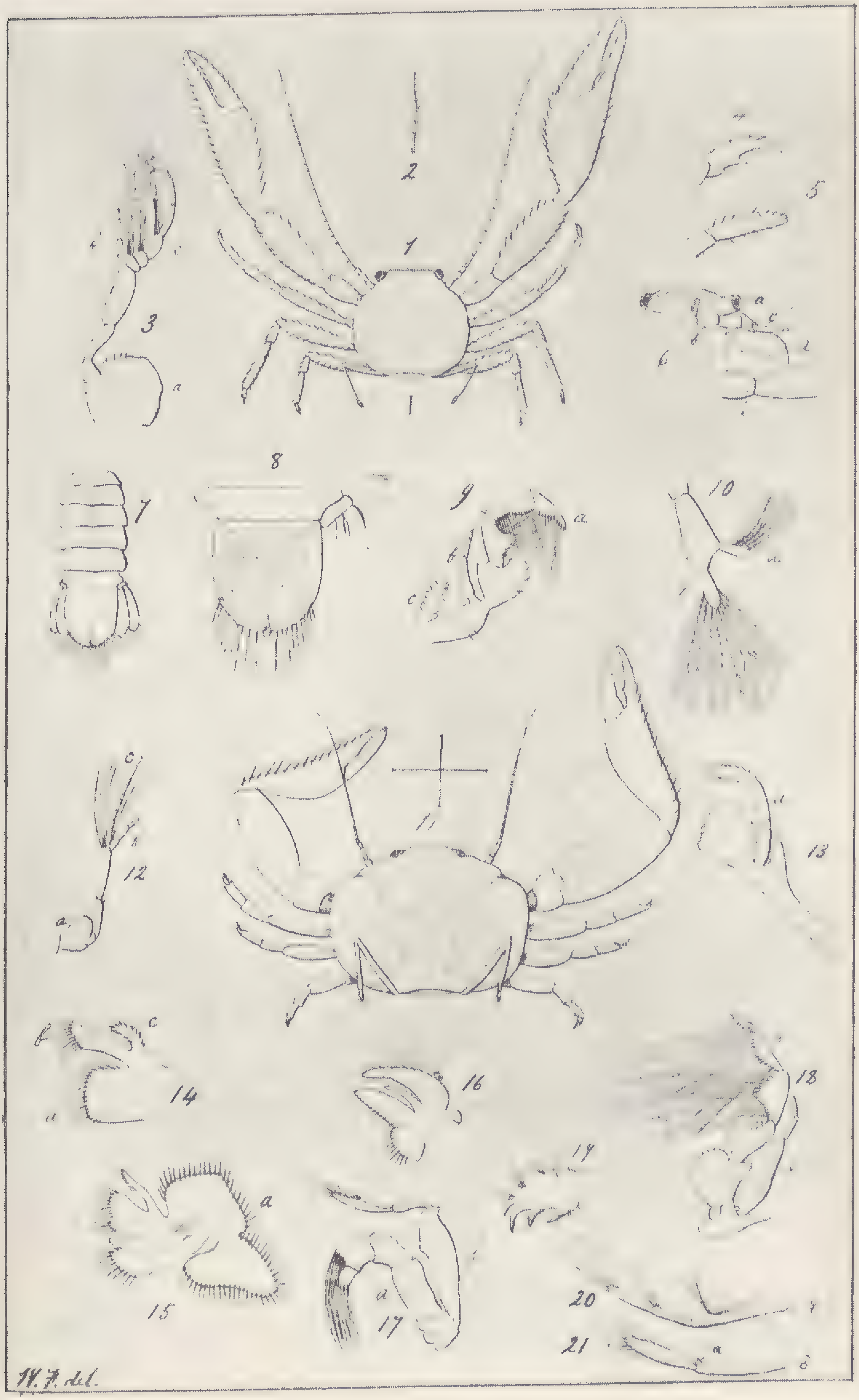
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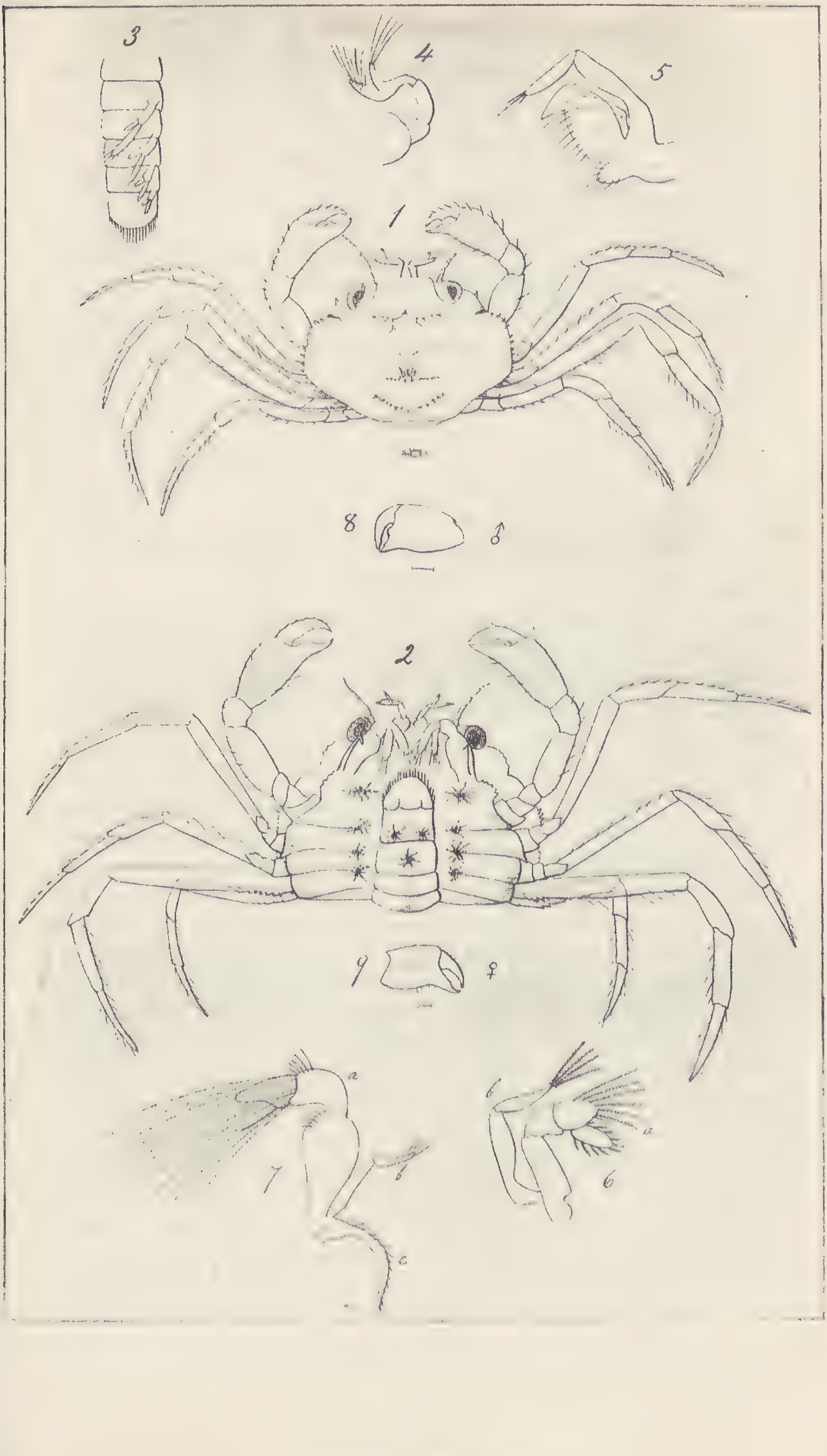

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No. 12.—*Reports on the Results of Dredging, under the Supervision of* ALEXANDER AGASSIZ, *in the Gulf of Mexico, by the United States Coast Survey Steamer "Blake,"* LIEUTENANT-COMMANDER C. D. SIGSBEE, U. S. N., Commanding.

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IV.

Preliminary Report on the Worms, by PROFESSOR ERNST EHLERS *of Göttingen.*

The collection of worms obtained by the Expedition on board the U. S. Coast Survey Steamer "Blake," in the Gulf of Mexico, during the months of January, February, and March, 1878, is very rich in material. A cursory examination of this collection confirms in general the relations which similar materials from the Hassler Expedition had already shown me; but the "Blake" Expedition has in a number of instances furnished a most desirable supplement to the results of the earlier expedition; worms unfamiliar to me, which in the latter were represented only by useless fragments, being here found in well-preserved specimens, and worm cases, which I had only seen empty, here occupied by their builders. I hope soon to present my complete report on both these collections, the publication of which has been delayed partly by the pressure of other engagements, partly by the time-consuming work of investigating and illustrating animals for the greater part undescribed. I give here only a mere summary of what I have received from the "Blake" Expedition. The collection was sent in seventy-eight bottles, the contents arranged by locality, being for the greater part so distributed that neither too many specimens nor too dissimilar species were placed together. This was important to their preservation, which was in general very good. With the contents of every bottle was a label recording the locality from which they came. On a few of the littoral species the name only of the place was given; but the greater part were marked with the number of the station, its latitude and longitude, and the depth in fathoms; a third lot was labelled in addition "Sigsbee," indi-

cating that the collection in question was referred to Captain Sigsbee's excursion in search of Pentacrinus mainly off Havana.

The stations from which the worms of the "Blake" Expedition were obtained are as follows: —

Key West, Bahia Honda, Tortugas. 2 miles off Havana. 128 – 240 fms.

Station No. 2.	4 miles off Morro Castle. 805 fms.
" " 5.	Lat. 24° 15′ N., Long. 82° 13′ W. 152 – 229 fms.
" " 6.	Lat. 24° 17.5′ N., Long. 82° 9′ W. 137 fms.
" " 9.	7 miles S. by W. from Sand Key. 111 fms.
" " 10.	Lat. 24° 43′ N., Long. 83° 25′ W. 37 fms.
" " 11.	Lat. 24° 3′ N., Long. 83° 25′ W. 37 fms.
" " 12.	Lat. 24° 34′ N., Long. 83° 16′ W. 36 fms.
" " 16.	Lat. 23° 11′ N., Long. 82° 23′ W. 292 fms. near Morro Light.
" " 19.	Lat. 23° 3′ N., Long. 83° 10.5′ W. 310 fms.
" " 20.	Lat. 23° 2.5′ N., Long. 83° 11′ W. 220 fms.
" " 21.	Lat. 23° 2.5′ N., Long. 83° 11′ W. 287 fms.
" " 23.	Lat. 23° 1′ N., Long. 83° 14′ W. 190 fms.
" " 26.	Lat. 24° 37.5′ N., Long. 83° 36′ W. 110 fms.
" " 29.	Lat. 24° 36′ N., Long. 84° 5′ W. 955 fms.
" " 32.	Lat. 23° 52′ N., Long. 88° 5′ W. 95 fms.
" " 33.	Lat. 24° 1′ N., Long. 88° 58′ W. 1568 fms.
" " 34.	Lat. 23° 52′ N., Long. 88° 56′ W. 600 – 400 fms.
" " 35.	Lat. 23° 52′ N., Long. 88° 58′ W. 804 fms.
" " 39.	10 miles N. of Jolbos Island.
" " 40.	Lat. 23° 26′ N., Long. 84° 2′ W. 1023 fms.
" " 41.	Lat. 23° 42′ N., Long. 83° 13′ W. 860 fms.
" " 43.	Lat. 24° 8′ N., Long. 82° 51′ W. 339 fms.
" " 44.	Lat. 25° 33′ N., Long. 84° 35′ W. 539 fms.
" " 45.	Lat. 25° 33′ N., Long. 84° 21′ W. 101 fms.
" " 47.	Lat. 28° 42′ N., Long. 88° 40′ W. 321 fms.
" " 48.	Lat. 28° 47.30′ N., Long. 88° 41′ W. 533 fms.
" " 49.	Lat. 28° 51.30′ N., Long. 89° 1.30′ W. 118 fms.

Sigsbee Stations.

Station No. 3.	Off Havana. 243 – 450 fms.
" " 5.	Off Havana. 100 fms.
" " 9.	Off Havana. 129 fms.
" " 14.	Off Havana. 175 fms.
	Lat. 26° 31′ N., Long. 85° 53′ W. 119 fms.
	Off Havana. 127 fms.
	Lat. 22° 9.30′ N., Long. 82° 23′ W. 158 fms.
	Off Havana. 175 fms.
	Lat. 22° 9.15′ N., Long. 82° 21′ W. 177 fms.
	Off Havana. 242 fms.
	Off Havana. 480 fms.

Annelids make up the greater part of this collection. Of other worms the Nemertinæ are represented by isolated fragments which do not admit of closer detailed description or identification; they are mainly littoral forms from Key West, from No. 5, and from "Sigsbee" No. 9, and off Havana 175 fathoms; none from the deep-sea stations. One single species of Sagitta found off Havana in 480 fathoms (Sigsbee) is of course not to be ascribed to that depth, but was undoubtedly brought up in the net by mere chance.

Gephyreans are represented in the collection by Sternaspis, Sipunculus, Aspidosiphon, and Phascolosoma: Sipunculus littoral from Bahia Honda, Sternaspis sp. from a depth of 158 fathoms, Aspidosiphon from 190 fathoms (No. 23), while many still undetermined species of Phascolosoma are littoral, and extend as far as the greatest depth here recorded, one species of Phascolosoma having indeed been brought up in a Dentalium shell from a depth of 1568 fathoms.

Although so numerous, these worms have but a slight significance as compared with the Chætopods of the collection. The occurrence of Chætopods in certain localities where the animals themselves are not found, may be inferred by the presence of their tubes. Yet such a conclusion is not always admissible without further evidence; at least only when the individual worm builds his tube in so characteristic a way that there is no possibility of mistaking it for that of other Annelids.* When no foreign material is used in the construction of the tube except mud consolidated by the secretions of the worm, the tubes of very different species of worms may have a great similarity among themselves; when, on the contrary, various foreign materials are cemented in the tubes, such marked peculiarities may occur in their choice and application that from a fragment of the tube the builder can be inferred with as much certainty as the snail from the form of his house; the form of the tubes may even be so peculiar that there is no danger of mistaking them for other tubes. Examples of this kind occur in the present collection, especially in the Eunicidæ, but also in the Maldanidæ, Sabellidæ, and Serpulidæ. In determining the distribution of the worms, the data furnished by the tubes must always be used with great caution; for it must be remembered that uninhabited tubes may be carried away by currents; in such instances they would usually be

* Several times I found tubes in the Hassler collection which from their whole appearance I should have taken for worm-cases; but the inhabitant was a Crustacean (Amphipod). I cannot decide whether in this case the occupant of the tube was also its builder.

filled by mud or by other ingredients of the bottom. I give below an enumeration of the families of Annelids which are represented in the collection; the numbers in parentheses show in how many of the above-named stations these families were found. Some idea may thus be obtained of the manner in which the several families are represented in making up the fauna of the region here investigated.

Amphinomidæ (4).
Chrysopetalidæ (1).
Aphroditidæ (3).
Polynoidæ (7).
Sigalionidæ (2).
Nephthydidæ (2).
Phyllodocidæ (2).
Hesionidæ (2).
Syllidæ (1).
Nereidæ (3).
Eunicidæ (34).
Goniadidæ (3).
Glyceridæ (1).
Ariciidæ (1).
Opheliidæ (2).
Scalibregmidæ (2).
Chloræmidæ (5).
Spionidæ (1).
Cirratulidæ (2).
Maldanidæ (5).
Amphictenidæ (1).
Ampharetidæ (5).
Terebellidæ (6).
Sabellidæ (2).
Serpulidæ (5).

According to their vertical range these families bear the following relation to each other:* —

The hundred-fathom line is not reached by the

Chrysopetalidæ,
Hesionidæ,
Syllidæ,
Nereidæ,
Scalibregmidæ,
Cirratulidæ.

The three-hundred-fathom line is not reached by the

Amphinomidæ,
Phyllodocidæ,
Glyceridæ,
Ariciidæ,
Terebellidæ,
Sabellidæ.

Below six hundred fathoms are found

Aphroditidæ,
Polynoidæ,
Eunicidæ,
Opheliidæ,
Ampharetidæ,
Serpulidæ.

Among the families here enumerated, none has so important a bearing on the character of the faunal region as that of the Eunicidæ, even should further investigation hereafter represent this fauna as having many additional special features. Their representatives are found in

* I should expressly state, however, that the material seems to me still insufficient for general conclusions.

far the greatest number of localities; they range from the littoral district to the greatest depths at which Chætopods have been found by this expedition (955 fathoms, Station No. 29). They are represented by the greatest number of genera (Diopatra, Onuphis, Eunice, Marphysa, Lisidice, Lumbriconereis, Arabella), and judging from the large number of their tubes found in many localities, they must form an essential part of the fauna. It is, however, easily seen that the various genera of this family show differences in their vertical range, the bearing of which will, perhaps, be more clearly understood when the conditions of temperature of their habitat are taken into account in connection with it. Thus the Eunice floridana (Pourt.), judging from the occurrence in great numbers of its paper-like irregular tubes, is a characteristic inhabitant of the littoral belt (as far as 100 fathoms). From deeper waters come the tubes of the Eunice tibiana (Pourt.); they descend (in the collection as far as 243 fathoms) about to the region where the Eunicidea of the species Diopatra and Onuphis appear, some of which build tubes which are frequently very peculiar.* Among these Chætopods species now appear which perhaps belong exclusively to the deep sea, and which, on account of the large leaflike expansions of the anterior appendages, and the presence of very long hooklike curved bristles at the point, may well be separated from Diopatra as a new genus. I have already pointed out the appearance in the deep sea of such Diopatra-like forms, with the anterior appendages considerably expanded.† The Diopatra group appears in this collection at about the hundred-fathom line; the group becomes particularly numerous at Station No. 44 at a depth of 537 fathoms, and has one representative at a depth of 955 fathoms.

In connection with the important part here taken by the Eunicidæ in the faunal combination of a marine area, it is interesting to remark that among the Annelids found in the lithographic shales of Bavaria the Eunicidæ are just those which, in various forms, are most richly represented.‡

Among the other families found at great depths, the Polynoidæ, with the Aphroditidæ, may be especially mentioned. But as they are never found in communities, and do not, as a rule, build large tubes,

* Here belong the flat, parchment-like tubes with cemented sponge spicules, and others mentioned by Pourtalès (Bulletin of the Mus. of Comp. Zoöl., Vol. I. p. 109) of Diopatra Pourtalesii, n. sp.

† Zeitschrift für Wiss. Zoologie, Bd. 25, p. 52.

‡ Cfr. Palæontographica, XVII. p. 145.

they are, like the Opheliidæ, less characteristic of the localities to which they belong than the Maldanidæ and especially the Ampharetidæ, whose large tubes, built of mud, and sometimes associated with those of the Eunicidæ, must, judging from the masses in which they are found, be a marked feature of certain localities.

It interested me especially to find that the Serpulidæ also descend to great depths (860 fathoms) in this region of the sea, because, in working up the Annelids collected by the "Porcupine" Expedition, I had noticed the absence of the Serpulidæ at great depths, and left it undecided whether these forms were excluded, as they seem to have been, by the peculiar nature of the bottom or by the low temperature of the deep-sea water. The Serpula now lying before me, from a depth of 310 fathoms (Station No. 19), is full grown; in its locality the sea bottom, of the constitution of which I have no other knowledge, must have contained hard parts. From a depth of 860 fathoms (Station No. 41) comes an immature Serpula tube with the worm (Ditrupa?); and as from the same locality fragments of mud tubes are found, it is probable that the bottom is muddy, though perhaps not exclusively so.* The relations of temperature are not yet known to me from either locality.

* It is not uncommon in the deep water of the Gulf of Mexico to bring up rocky fragments from great depths, which, judging from the amount of mud brought up by the trawl at the same time, must have formed isolated patches. Of this I shall say more hereafter, when speaking of the characteristic features of the bottom of the Gulf of Mexico. As far as the temperature is concerned, I am preparing a general sketch of the temperature of the waters of the Gulf of Mexico, which is to appear in one of the forthcoming numbers of the Bulletin, illustrated by a selection from the numerous serial lines of temperatures taken by Lieutenant-Commander C. D. Sigsbee during the past four years. I may merely state here, in a general way, that, the surface varying from 74° to 80°, at a depth of 100 fathoms the temperature varies from 58° to 71°; at 200 fathoms, from 48° to 65°; at 300 fathoms, from 44° to 63°; at 400 fathoms, from 41° to 61°; at 500 fathoms, from 40° to 56°; at 600 fathoms, from 39½° to 47°, while below 600 fathoms to 2000 fathoms, it varies from the above to 39°; the sections from Tortugas to the Yucatan Bank showing a higher temperature than we find in the section from the mouth of the Mississippi to the Yucatan Bank. A section of still higher temperatures is shown across the line running from Cape San Antonio to the Yucatan Bank, a section of somewhat lower temperature across from Tortugas to Port Mariel (Cuba), and one very slightly lower still from Cape Florida to Gun Key. — ALEXANDER AGASSIZ.

CAMBRIDGE, May 1, 1879.

No. 13. — *On the Classification of Rocks.** *By* M. E. Wadsworth.

The results sketched in this paper, which will be given in greater detail elsewhere, were derived from the study of collections made in California, Lower California, Arizona, Nevada, Oregon, the territory covered by the Exploration of the Fortieth Parallel, the Lake Superior Region, New England, Costa Rica, and in Europe. The consecutive western area represented by these collections includes some three hundred thousand square miles, extending over one thousand miles in each direction. As this comprises one of the most extensive volcanic regions on the globe, which also contains old crystalline and sedimentary rocks, it affords a wide field for generalization.

Knowing the tendency of the human mind to fall into error, I can but feel that in avoiding the mistakes of others I may have committed greater ones myself. However this may be, my duty is none the less plain to give the facts as I understand them, let the result be what it will.

This work has been done at the private expense of Professor J. D. Whitney, in continuation of his work upon the State Geological Survey of California, and will be published in full in the Memoirs of the Museum of Comparative Zoölogy at Harvard University. If this paper has any value, the credit belongs to Professor Whitney, as without his generous liberality the work could not have been done; if valueless, the blame rests upon me, as I have had entire freedom in this work, and no one but myself is responsible for a single sentence contained herein.

My thanks are due to Mr. Clarence King, for his great courtesy in allowing me to examine, for some weeks, the rocks and slides belonging to his former Survey, which had been studied and reported upon by Professor Zirkel, and for his placing at my disposal his microscope during the examination; to the officers of the American Museum of Natural History in New York, in whose building the collection was deposited, for their efforts to facilitate my work; also to Mr. George W. Hawes of Yale College, for the privilege of examining his New Hampshire collection.

* Abstract of a thesis presented for the degree of Doctor of Philosophy in Harvard University, March 25, 1879; also given before the Boston Society of Natural History, May 7, 1879. The references and the numbers of the sections, which are fully given in the original, are omitted here.

The thin sections belonging to Professor Whitney's collections were prepared by Mr. J. H. Huntington, late Assistant Geologist on the Geological Survey of New Hampshire, whose preparations have been far superior to the other American work on rock sections that I have seen, and are fully equal, if not superior, to the German work sent to this country.

All classifications of rocks in vogue at the present time are, with one exception, confessedly artificial, as one can readily see by examining those proposed by Naumann, Blum, Von Cotta, Zirkel, Dana, Lang, Lasaulx, Rosenbusch, Roth, and scores of other writers of more or less note. The one exception is that scheme for the Tertiary volcanic rocks given by Baron Richthofen in the Memoirs of the California Academy of Sciences (Vol. I. Part II., 1868), in which he announces that, beginning with the Tertiary age, volcanic rocks succeed one another in massive eruptions in the following order: propylite, andesite, trachyte, rhyolite, and basalt. Having laid down this order, his classification then becomes largely artificial.

The usual classifications have been based on structure, age, mineralogical composition, chemical composition, and upon almost every part of the rock separately, but never on the entire rock as a unit. But little attention has been paid, when the scheme was based on mineralogical characters, whether the minerals were foreign, original, or alteration products. If the same minerals existed in two rocks, no matter if the minerals in one were products of the crystallization of the cooling magma, and in the other alteration products, both rocks were classed as the same, even if there existed a difference of silica amounting to over twenty per cent.

If we adopt the mineralogical classification, we are met by the fact that the feldspars cannot be distinguished from one another, in spite of the method of Des Cloizeaux, and its ingenious modification by Professor Pumpelly, — methods that fail exactly where they are most needod.

Furthermore, our best chemists and mineralogists are not agreed as to what are the species of feldspar, — a point that it would be well to settle before the classification of rocks is made wholly dependent on the feldspathic constituent.

Quartz, hornblende, augite, monoclinic and triclinic feldspars, and magnetic iron are found extending through rocks of every age and of every percentage of silica. The quartz and hornblende exist as foreign, as indigenous, and as alteration products, — distinctions that should be noted in employing these minerals in classification.

No natural distinction can be drawn between rocks of the Tertiary and Pre-Tertiary ages, since the glass and fluidal inclusions, crystalline texture, and the various other characters fail, exactly where they are most needed, to divide the rocks into older and younger, as is done by the majority of lithologists.

The writer believes that rocks should be studied, by beginning with their most compact or glassy state, and by then tracing them through to the most crystalline form, following every alteration, whether it be chemical or mechanical. Every rock that can be traced in this way forms a distinct species, whatever may be its state, — whether amorphous, glassy, crystalline, fragmental, tufaceous, or otherwise, — and whatever may be its age. The modifications, if of sufficient importance, form varieties simply, which should be included under the specific name. A natural classification of rocks must be empirical, and must be based on the rock as a whole, while a natural mineralogical classification is an impossibility, as it is based on part of the characters only.

If we except the veinstones and the majority of those rocks that are composed of one mineral, the species of rock forming the crust of the globe are very few. Believing that this earth is a cooling globe, all manifestations of internal heat giving rise to rocks (the only thing with which we are at present concerned) are here termed volcanic, and all such products are styled volcanic rocks. The testimony of the rocks is that all sedimentary forms came primarily from volcanic ones, volcanic energy having been more active than now in the past ages of the globe. This derivation is consonant with that which we see taking place at the present time, and agrees with the law of dissipation of energy; while the reverse view, at present popular, — that eruptive rocks were derived from sedimentary ones, — is contrary to the positive testimony of the rocks themselves, to the facts that are observed in nature, and to physical laws.

Taking the consolidation of any rock as its initial point, the minerals and rock fragments contained therein fall naturally into three classes: 1. Minerals and fragments of prior origin; 2. The products of that consolidation; 3. The products of alteration and infiltration.

These three classes are most marked in the volcanic rocks, as is natural; the first two predominating in the younger and least altered, the latter in the older and more altered ones, while the first and third classes predominate in sedimentary rocks. These alterations apparently take place through the agency of the ordinary percolating waters, which are not necessarily hot. The minerals and fragments of the first class,

I find, fall into two divisions in the volcanic rocks: 1. Those that are characteristic of the rock species, and which were probably derived from the re-fusion of this species, that had crystallized at the depth at which it was prior to the eruption; 2. Those that are accidental, probably caught in the passage upward or during the outflow. Similar divisions are found, to a greater or less extent, in the sedimentary rocks, according as they were derived from one or more rocks, and also according to the preponderance of different rock fragments and minerals in them. Details of these occurrences will be given in the final publication.

Believing that new names should not be employed, except in cases of absolute necessity for filling gaps in the classification, the effort has been made to retain all the old names that are necessary, in their most general use, and to reject all needless ones, that can be so dealt with.

Starting with the basic rocks, I shall pass from the glassy states to the most crystalline, from the least altered to the most altered, and from the massive to the clastic, keeping on a similar range of chemical composition, and tracing the various gradations step by step. I shall also, in like manner, trace the gradations from the basic to the more acidic rocks, showing the gradual changes that exist in that direction as well. Since, owing to the necessities of the case, both in the use of these observations in a thesis and in giving a post-graduate course in lithology in this Museum, my work was made public before it was entirely completed, it has been deemed necessary to publish this abstract in advance. Several matters of detail yet remain to be worked out, which may modify some of the general views. All that is liable to be so modified must, therefore, be withheld for the present.

Commencing with the basalts, we find a bluish-black glass, giving in the thin section a yellowish-brown glassy base, holding a few crystalline secretions. This glass passes in the same specimen into a dense black, globulitic base, with the same mineral secretions. We then pass on to specimens that contain less of the globulitic base and more and more of the crystalline minerals, plagioclase, a little sanidin, magnetite, olivine, and augite. As the rocks become more crystalline the feldspars take positions diverging more and more from one another, holding cuneiform masses of the globulitic base between them, which base, as we proceed, is replaced by grains of augite, olivine, and magnetite. The feldspar is chiefly plagioclase, and is usually in narrow, ledge-like forms.

The olivine is mostly in rounded and broken crystals and fragments, showing oftentimes a blackening of its edges by the heat of the molten

magma, which has torn and eaten its way into the olivine substance. Occasionally we see only little heaps of black grains left from the destruction of the olivine, every gradation being traced from these to the only slightly attacked olivine. Similar grains are scattered through the groundmass, giving rise to the belief that part of the magnetite found in the basalt was derived in this way, as the crystals of olivine are often found to be magnetic. The augite, unlike the olivine but like the feldspar, is a direct product of crystallization from the cooling magma. It is found to vary inversely with the olivine, and to crystallize with that mineral in such a manner as to lead to the conclusion that the augite is derived from the crystallization of the olivine material mixed with a certain proportion of the base. The olivine is very rarely the product of crystallization of the magma, but belongs to the minerals of the first class. The more coarsely crystalline of the basalts are known as dolerites and anamesites; the same general characters also hold good in the leucite and nephelite varieties.

The basaltic rocks are more subject to alteration than any others, the variety of alteration products diminishing as the silica increases. This alteration affects the olivine and base first, the latter often becoming somewhat fibrous, forming a base called by the German lithologists "micro-felsitic." Under this term they have utterly confounded the original micro-felsitic base of the unaltered andesites, and of some allied rocks, with the alteration and devitrification products in the basalts, andesites, trachytes, rhyolites, felsites, etc. Further alteration obliterates the base, and, one after another, the minerals in the rock, the feldspar usually being the last to disappear. These changes give rise to the presence of hydrous oxides and silicates, carbonates, etc. The chief proportion of quartz in these altered rocks is a direct product of alteration, derived from the base and the silicates in the basalt. The fine-grained, compact basalts through their alteration give rise to the variety known as melaphyr, while the coarser-grained ones, like the dolerites, in like manner form the diabases and the great majority of the basic rocks known as diorite, — a name that is at present the most abused one that occurs in lithology, as it is made to cover, not only old basalts, andesites, etc., but also the granites of the Sierra Nevada. May it soon be dropped! The still more coarsely crystalline varieties, when altered, give rise to the gabbros and peridotites. Under the former of these should be placed the majority of the euphotides, in which the saussurite is an altered feldspar. For the special descriptions and the tracing out of these changes, reference must be made to the original paper. The

percentage of silica in all these basalts lies usually between 45 and 55 per cent, generally averaging about 49 per cent.

The unaltered fragmental forms of the basalts, as well as of the other volcanic rocks, are called tufas, while I have denominated all the altered and old fragmental forms as *porodites*, since at present we have no name in the science that covers that class of rocks. The poroditic forms, of course, closely resemble the rocks from which they were derived, and separation is often impossible in the field, the true character being told only by microscopic examination. To this difficulty of distinction is owing the often repeated assertion that sedimentary rocks pass into eruptive ones, — an assertion that has not proved true in the few cases that have come under my observation. It fails, in like manner, under the examination of other investigators, if recent petrographical literature is to be taken as a guide. Classing the various forms given above as varieties under the species basalt, the scheme is as follows: —

Basalt	Feldspar Leucite Nephelite	Basalt Dolerite	Melaphyr	Tufa.
			Diabase Gabbro Peridotite	Porodite.

Serpentine, when derived from the alteration of a peridotite, as is the case with some from California, would be classed under this variety.

Passing on to the more acidic species, the rocks usually known as andesites come next in order, ranging in silica usually from about 55 to 65 per cent, but generally averaging about 61 per cent. We have a gradual passage from basalt, with its globulitic base, rough groundmass, and accompanying minerals, into a rock having a dark to light-brown glass for its base, filled with microlites, and generally somewhat globulitic. Olivine is rarely seen in this; augite becomes abundant, in well-formed crystals; plagioclase predominates, but sanidin is more abundant than in the basalt. The color is a blackish-brown or gray, somewhat lighter than in basalt, and the structure of the rock is more porphyritic. The next form, usually classed as andesite, including also some so-called trachytes, has a gray micro-felsitic base, filled with microlites, enclosing similar minerals, and is of like structure but usually of a lighter gray color. Both contain, oftentimes, more or less hornblende, which plays here the same rôle that the olivine does in basalt. This hornblende is a mineral of the first class; its edges are often blackened, the crystals rounded, broken, blackened on the broken parts, and gnawed into by the molten magma. Sometimes this blackening and destruction extend so far that only little heaps of black grains are left, while similar grains are also scattered through the groundmass.

The blackened parts of this brown hornblende are magnetic, and it is probable that much of the magnetite scattered through the groundmass came from the destroyed hornblende. Often these hornblendes, occurring in the andesites that have a reddish color, have been torn into ferritic fibres, which have been heaped up or else scattered throughout the groundmass. These changes have apparently been produced by the remelting of pre-existing rocks of the same kind. The augite varies inversely with the hornblende, and in its relations to that mineral leaves no doubt that it comes from a recrystallization of the hornblende material dissolved in the magma.

The feldspar and augite are here products of crystallization of the magma. These rocks are subject to alteration, but in a less degree than the basalts, the changes being somewhat similar, and giving rise to several varieties now classed by lithologists as distinct species, some of the most important of which are propylite, porphyrite, hornblende-porphyry, black porphyry, part of the felsite or felsite porphyry, diorite, etc. No distinction can be legitimately drawn between the hornblende and augite andesites, on account of their mutual relations, as given above; as well might we have olivine and augite basalts.

We next pass into that most obscurely defined of the volcanic rocks, trachyte, which has been made to include the rhyolites on one side and the andesites on the other. The range of silica here is perhaps from 65 to 70 per cent. The base is a light-gray, almost colorless glass, somewhat micro-felsitic; sanidin begins to predominate, the plagioclase diminishes, biotite appears, and the hornblende is partly now a mineral of the first class and partly of the second. Augite rarely occurs, while quartz, which has been occasionally seen as a mineral of the first class in the basalts and andesites, begins to be more abundant. This, like the others, has its old and altered forms.

Next we pass on to the rhyolites, which contain from about 70 to 80 per cent of silica, possessing a clear, glassy base, which is, however, often colored by foreign materials, holding crystals and fragments of quartz belonging to the minerals of the first class, and more abundant sanidin, biotite, and hornblende, crystallizing out of the magma. The base is most prominent in the compact rhyolites, and its devitrification gives rise to the various structures that characterize them. This devitrification gives rise in the older and more altered rhyolites to the feldspar, quartz, and micro-felsitic (so-called) base, that has so puzzled lithologists in the study of the felsites. The rhyolites of all volcanic rocks pre-eminently show lamination produced by flowing,

a fact which is doubtless due to their base being so siliceous. This structure and their devitrification enable us to trace a direct connection between the rhyolites and felsites, which are simply the older and more altered rhyolites. One of the best illustrations of this is to be found on Marblehead Neck, Mass., where at least two distinct flows of felsite occur, one cutting the other. They show the fluidal structure so characteristic of rhyolites, — a character that has been mistaken for lines of sedimentation by geologists, while the enclosed crystals of orthoclase have been taken for pebbles.

These felsites are not stratified, and, contrary to the positive assertion of Dr. T. Sterry Hunt, they are younger than the granite on the Neck, and cut it; also dikes of the felsite are seen cutting the granite. Furthermore, there is no passage of a conglomerate into a felsite in this locality, as macroscopic and microscopic observations prove. While to the naked eye and under the microscope this rock shows the fluidal structure of a rhyolite, in polarized light it is seen that the base has been completely devitrified, a process that is carried to a great extent in many known modern rhyolites.*

The various old rocks, designated by a multiplicity of names, fall into one and sometimes two or more of these species, according to the exactitude with which the name has been used in the past. The derived rocks can be referred to the parent ones with greater or less difficulty according as they were derived from one or more species, and also according to the changes that they have suffered. The tracing out of the natural relations and history of rocks is the most valuable and philosophical work to be done at present in this department of study, — work which never can be finished until the sum of human knowledge is complete, but which, as far as lies in my power to do with the collections now at my disposal, I hope to place before the public next year.

It is found in those rocks which show signs of long-continued cooling that the base diminishes and the crystalline minerals increase, the base occupying the interspaces between the crystals. When this process was carried to sufficient extent, as it was in the deeper-seated and older rocks, the chemical bases crystallized out of the rock base, leaving the superfluous silica in the form of quartz occupying the same interspaces. This process has taken place not only in the acidic granites but also

* Mr. J. S. Diller, who has been studying lithology under my direction, has undertaken, as a subject for his thesis, the field and microscopic relations of some of the felsites of Eastern Massachusetts. He has already made some important observations, and I hope his work will solve the vexed question of their relations.

in some of the basic gabbros. No inference, it seems to me, can be drawn regarding the heat to which a liquid has been exposed from either the pyrognostic or thermo-optical characters of the minerals that crystallize out on its cooling, or from the order of this crystallization. Thermo-optic and pyrognostic observations will prove to be of value, doubtless, when applied to those minerals that belong to the first class in volcanic rocks.

As far as my own observation has gone, and as far also as can be told from the observation of others, no sulphide, no carbonate, nor any hydrous mineral whatsoever, is the direct product of crystallization of the fluid magma, but all these are the products of alteration and infiltration after the consolidation of the lava, as are also part of the feldspar and quartz, as well as all of the epidote, etc.

Cases of envelopment are of constant occurrence among the minerals of the second class, but they bear no resemblance to those cases of alteration that Dr. Hunt has endeavored to place under the head of envelopment, and which are so abundantly seen in the altered rocks.

The alterations that take place are not usually attributable to extraneous material brought in by infiltrating waters, but are rather molecular changes brought about by the percolating waters within the rock mass. Except, therefore, on the weathered portions or in some rocks exposed to abnormal conditions, while the mineral constituents change through chemical rearrangement, the ultimate chemical constitution of the rock, as a whole, remains nearly constant.

The microscopic and chemical characters of volcanic rocks are opposed to the idea that they came from sedimentary ones, as the inclusions of the first division of the first class are nearly constant for each species, — a thing which could not happen if they were derived from the fusion of sediments, since a heat which has not obliterated hornblende crystals was certainly not great enough to destroy all the materials of which our sedimentary rocks are composed. While the chemical composition of these rocks indicates a somewhat uniform origin, that of the sedimentary ones shows generally a mixed one, as we know is the case with the majority of them.

The materials of the first division of the first class, too, in each species are only of such rock species as itself or of those that we know have preceded them in order of time; as, for instance, in rhyolite we find fragments of rhyolite, trachyte, andesite, and melaphyr or diabase, but, so far as I have seen, never an unaltered basalt. Rhyolite, being the most refractory of the volcanic rocks, is usually the most brecciated; and

those geologists who hold that conglomerates have been metamorphosed into felsites, have forgotten that conglomerates are usually mixed rocks, while in the cases cited by them the pebbles are felsites, the same as the felsite into which they are said to be changed. We should expect, when an outflow takes place, that there would be a re-heating and breaking up of the old lava in the vent, which would naturally give us this brecciated material. However old the rocks may be, the materials of the first class in each species remain the same in character, from the earliest ones that I have examined down to those of the present time. The alterations to which volcanic rocks and their derived sediments are subjected make it often difficult to distinguish one from the other; but this difficulty arises, not from the sedimentary rock assuming, under any agency to which it is naturally subjected, the form of a volcanic one, except so far as it retains the characters and alterations belonging to its parent rock, but from the volcanic one taking from alteration, characters closely like those of sedimentary rocks. I have never found, under the microscope, the sedimentary characters obliterated in the most highly metamorphosed rocks that were known to have a sedimentary origin; and, furthermore, the minerals and mineral varieties of the third class in sedimentary rocks are, with possibly one or two exceptions, never like the minerals arising from the crystallization of any lava. The supposed passage of a sedimentary rock into an eruptive one can only be considered proved when it is shown positively that the observer knows the nature of the rocks in question, and that he has examined every inch of the portion lying between them, so as to be able absolutely to prove that no line of junction can exist. One such case worked in that way would prove the entire question in favor of the popular geological school.

The Geological Exploration of the Fortieth Parallel adopted, with modifications, Richthofen's classification of the Tertiary and recent volcanic rocks, and Mr. King, in his report, states that each of these rocks shows always a basic, mean, and acidic form. He classes rhyolite as the acidic form of basalt, placing both under the head of neolite. As my examination of Mr. King's collections convinces me that his system is based on errors, it is well to point out briefly some of these, taking, of course, the report of Professor Zirkel as the basis, and following, in a measure, its order.

The mica schist that Professor Zirkel calls a paragonite slate, like that from St. Gotthard, is similar to many mica schists in New England, and, except that its color is grayish-white, has no resemblance to the

paragonite schist from St. Gotthard. It is, furthermore, destitute of disthene, although he says it contains "excellent large crystals of pale-blue disthene."

His granite porphyries belong in part to granites and gneisses and in part to the felsites, and his syenites are old and much decomposed andesites, in which the quartz is an alteration product.

The diorites are partly sedimentary rocks, partly granites and felsites, partly old andesites, and the rest are old basalts.

The so-called hornblende porphyries are somewhat altered andesites, and the diabases are mainly altered basalts, but a few are unaltered ones, the remainder being altered old andesites. The melaphyrs are all old, altered basalts, except one, which is an old andesite.

The propylites are all altered andesites, with which species their chemical composition agrees; and the diagnostic distinctions that Professor Zirkel has placed between the andesites and propylites do not hold good even in the specimens that he described, as would have been readily seen had he given complete descriptions instead of the very imperfect and often inaccurate ones that have been published. The distinction between these rocks is simply in the degree of alteration, and they pass directly into each other. With but two exceptions, the quartz propylites are old granitoid, felsitic, and fragmental rocks, while the two exceptional ones are altered andesites, in which the quartz is an alteration product. Rejecting, then, the so-called propylites that are not propylites, the range in silica is from 58.66 per cent to 64.62 per cent, or about 6 per cent, as shown by Mr. King's list of analyses.

No line can be drawn between the hornblende and augite andesites, but both form one continuous series, Professor Zirkel being mistaken in his statement that the augite andesites are younger than the rhyolites. Beginning with the andesites, the volcanic rocks have been described and arranged very indiscriminately, rhyolites being described in his report as trachytes, trachytes as andesites, and rhyolites and basalts as trachytes, etc. Only a few of these cases can be pointed out here. All the dacites, with one exception, are rhyolites, felsites, and fragmental rocks not belonging to andesites. The exception is an altered andesite, in which the quartz is an alteration product. Referring again to Mr. King's tables of analyses, we find the range of silica in the undoubted andesites to be from 58.33 per cent to 62.71 per cent, or a little over 4 per cent. Analysis 140 is that of a rock referred with doubt to the andesites.

The analyses of the trachytes seem best to bear out Mr. King's idea; but on looking over the list of analyses, and omitting those of rocks which were not described since they lay outside of his district, only two or three remain that can be considered as trachytes, viz. Nos. 154 and 155, and possibly 153. The rest belong to quartz-bearing basalts and to andesites. The basalts that have been described as trachytes are not doubtful ones, that might naturally have been classed with the trachytes, but are well-marked specimens, identical with some that have been described under the head of basalt in the same report. Attention should also be called to the fact that, contrary to Mr. King's theory, the quartz-bearing trachytes of Professor Zirkel's report are basic rocks (true basalts), and his typical augitic trachytes are acidic ones.

Regarding the union of the basalts and rhyolites, it should be remembered that they have not a single character in common, and also that the highest analysis of basalt published by Mr. King differs by fourteen per cent of silica from the lowest analysis of rhyolite. Professor Zirkel's method leaves the presence of nephelite very doubtful, certainly not proved. My examination shows that part of his nephelite-bearing rocks are andesites and the remainder basalts, in all of which the presence of nephelite is very doubtful. His supposed haüyne seems to be nothing but some grains of ultramarine rubbed off the boxes and enclosed in the balsam used in mounting. After careful study of the reports and collections of the Fortieth Parallel Survey, and of collections of the same rocks in the same and adjacent regions, I am unable to find any basis for Mr. King's classification, or for his theory of the genesis of volcanic rocks. In studying propylite I have not only examined the collections mentioned above, but have also had constantly at hand Baron Richthofen's collection made in California and Washoe. Placing propylite under andesite, as an altered form of the latter, Richthofen's law of succession seems then to be an observed order of occurrence in a comparatively brief geological period, and as such is hardly at present entitled to be considered a law. When it will express the order of succession during all time, and the reasons for that succession, then, and not till then, will it rank as one of nature's great laws.

We need more accurate field, microscopic, and chemical work on unaltered rocks, and a more careful study of our rock species in all their relations, since the best descriptions are at present so imperfect as to be of but very little value.

It is to be noticed that only so many minerals form in a lava as can crystallize during the time of cooling, and the interchange of chemi-

cal elements between two points not in juxtaposition is very slow in such a pasty mass. The crystallization will then be imperfect, as will also be the removal of the chemical elements from the base in rapidly cooling magmas. These facts, together with the diverse origin of the rock minerals, have served to render futile all attempts to determine by chemical analysis the minerals and the percentage of each in rocks.

In those rocks which contain an unaltered base, I find that the base is a surer index of the chemical composition, if we must be restricted to one thing, than the enclosed minerals are.

Exact field, microscopic, and chemical investigations are needed upon the vein-stones, ore deposits, and sedimentary rocks, as well as upon the eruptive ones, — work which promises a fruitful harvest for the earnest laborer. If the signs of the times are read aright, the day is not far distant when the battlefield of that all-embracing science, geology, will be transferred to the domain of petrography; and no young geologist who desires to stand in the front can afford to be ignorant of the modern lithological methods.

Cambridge, May, 1879.

ERRATA.

Page 290, 16th line, for Hetropods, read Heteropods.
,, 293, 12th ,, for diameter, read circumference.
,, 295, 23d ,, for Phoronema, read Pheronema.
,, 297, 6th ,, for *Hemyeuryale*, read *Hemieuryale*.
,, ,, 7th ,, for *Ophiocanax histrix*, read *Ophiocamax hystrix*.
,, ,, 14th ,, for Astrochema, read Astroschema.
,, ,, 29th ,, for Actinæ, read Actiniæ.
,, ,, 31st and 38th lines, for Umbellariæ, read Umbellulariæ.
,, 298, 8th line, for *zealacus*, read *zaleucus*.
,, 299, 13th ,, for Anthipates, read Antipathes.
,, 302, 38th ,, for Gallopagos, read Galapagos.

No. 14. — (Letter No. 3.) *To* Carlile P. Patterson, *Superintendent United States Coast Survey, Washington, D. C., from* Alexander Agassiz, *on the Dredging Operations carried on from December,* 1878, *to March* 10, 1879, *by the United States Coast Survey Steamer "Blake," Commander* J. R. Bartlett, *U. S. N.*

(With two maps.)

I joined the "Blake" at Washington, on November 27, 1878, for a second dredging cruise. According to your instructions, we intended to proceed to Nassau, and there devote a few days to dredging and sounding, in order to trace the connection between the fauna of the northern extremity of the Bahama Banks and that of the Straits of Florida. Owing to rough weather this was not deemed prudent, and we were compelled to put into St. Helena Sound, and, for the same reason, when off Jupiter Inlet, instead of crossing the Gulf Stream to make Nassau, it was thought best to put in to Key West. From there, when the weather moderated, we started for Kingston, Jamaica, calling at Havana for the purpose of making a couple of hauls on the Pentacrinus ground discovered by Captain Sigsbee off Morro Light. We made two casts of the dredge in 175 to 400 fathoms, and obtained a few specimens of Pentacrinus. We kept on along the northern shore of Cuba, through the Old Bahama Channel, without stopping to sound or dredge, Mr. Pourtalès having, in former years, dredged and sounded, in the "Bibb," Acting Master Platt, U. S. N., over the greater part of this line.

At the eastern end of the Old Bahama Channel we ran a line of dredgings and soundings across from Caya Cruz to Lobos Light. In the deepest part of the channel we found only 500 fathoms, although the hydrographic maps indicated 900 fathoms, no bottom. This is an excellent example of the uncertainty of the old method of sounding with hemp rope, even in moderately deep water, when there is a strong current, such as we found here.

Nothing of special interest came up in any of the casts made either with the trawl or dredge. Wound around the steel-wire rope on this line, however, we found a few pieces of the deep-sea Siphonophores (Rhizophysa), described lately by Studer in the Zeitschrift f. wissen. Zoologie. Subsequently we frequently found more or less complete specimens of these Siphonophores, generally entangled on the wire rope

or attached to the trap of the trawl. Studer gives a long list of the depths from which they came up attached to the sounding-line, but it is by no means certain that these Siphonophores belonged in the depths indicated by the wire. They may have become caught on the wire while it was reeling in at only a short distance from the surface.* The fact that Studer never succeeded in bringing up any of these species in the tow-net, even when lowered to a considerable depth, is as little conclusive, since, at any rate in the Caribbean Sea, their isolated parts and fragments are not uncommon floating on the surface. It is probable that they usually live at a certain depth below the surface, and some of them may, like Cassiopea, prefer to dwell near the bottom; but until we possess a net so constructed as to give some sure indication of the intermediate depths at which the animals living at various distances between the surface and bottom have been gathered in, it seems hazardous to define the bathymetrical range of a large number of pelasgic animals, such as the Acalephs, Siphonophores, Hetropods, Pteropods, numerous Foraminifera, Radiolaria, and the like, the habits of which are scarcely known.

In the case of Fishes, when dredging in deep water at a moderate distance from the land, we ought not to take it for granted that they invariably live at the depth to which the trawl may have been lowered. The young of many of the deep-water Fishes are undoubtedly pelasgic, often till a late period of growth, and thus many of the deep-water Fishes have probably come to light, especially in the proximity of oceanic islands or along coasts situated near deep water. We made three casts off the coast of Cuba, between Nuevitas and Cape Maysi. In lat. 21° 2′, N., long. 74° 44′, W., off Cayo de Moa, in 1,554 fathoms, we found a patch of green sand, made up of large Globigerinæ, similar to that mentioned by Mr. Pourtalès in his "Deep-Sea Corals."

We also obtained, in 994 fathoms off Nuevitas, large blocks of genuine white chalk, composed mainly of Globigerinæ and Rotulinæ. Large quantities of ooze and white clay, which proved to be only the white chalk in different stages of compression, also came up in the trawl. If the conditions now existing at that depth at all resemble those of the time of the white chalk, I could readily understand how perfectly Sea-Urchins or Mollusks would be preserved if once enclosed in this homogeneous substance, to be gradually compressed into solid white chalk.

In one of the hauls taken between Cape Maysi and Jamaica (1,200

* In one case, dredging in 1,000 fathoms, numerous fragments of a Rhizophysa came up after drawing in 100 fathoms of wire! On another occasion, the same species came up after drawing in 300 fathoms, while dredging in 500 fathoms.

fathoms), we obtained the first specimens of Phormosoma I had seen alive. I was much astonished to find them, fully blown up, hemispherical or globular in shape. This was the shape they always took in subsequent hauls, and on several occasions, when they were obtained from comparatively shallow water, near the 100-fathom line, they came up fully alive and retained their globular outline. The alcoholic specimens I had seen in the "Challenger" collections came up as flat as pocket-handkerchiefs, from great depths, and were naturally regarded as flat Sea-Urchins, although of course endowed with great mobility of test. These Echini, with their globular, flexible tests, recall vividly the Perischoechinidæ, with which they have also points of resemblance of great interest in the structure of their ambulacral and interambulacral plates.

In the dredgings taken off the southeastern end of Jamaica we did not bring up anything of great importance. From Jamaica we were obliged, owing to the strong trades, to keep on toward St. Thomas, without either sounding or trawling till off Porto Rico. During the winter months the trades blow sufficiently hard to make dredging and sounding quite uncomfortable on a vessel of the size of the "Blake." We had, therefore, no opportunity of adding anything to the hydrography of that part of the Caribbean Sea.

On arriving at St. Thomas we made a programme for our season's work. This we were fortunate enough to carry out to the letter, as far as the dredging and sounding were concerned. With the exception of the time required for coaling and overhauling the engine at Martinique and St. Lucia, not a single day was lost. Although Lieutenant-Commander Sigsbee, U. S. N., did not command the "Blake," yet the improvements which were made this year in the dredging and sounding apparatus were all carried out under his supervision, the vessel having been fitted out for sea before he was relieved by Commander J. R. Bartlett, U. S. N., who commanded the "Blake" during this winter. It was also my good fortune to find on board the majority of the officers with whom I sailed in the winter of 1877 – 78 : Lieutenant Sharrer, the executive officer, Messrs. Jacobi, Peters, L. P. Sigsbee, and Dr. Nourse. Now, as before, I was indebted to their cordial interest and efficient assistance, as well as to that of Lieutenant Wallis, Mr. Pemberton, and Mr. E. L. Reynolds, who had joined the "Blake" for the first time. We thus started under the very best auspices. In the use of the improved machinery, suggested by our former cruise, the experience of the old officers saved us from the annoyances which always accompany the

introduction of new methods. The "Blake" was this year provided with a new, double-cylinder reeling-engine, built by Copeland & Bacon, placed at right angles to the reel, on which our steel rope was wound. A small double engine revolved the reel, so that the wire rope was wound independently of the main reeling-engine. The wire rope was led to the port side directly from the main reeling-engine, then by a large, wrought-iron sheave along the deck to the mainmast, thence across to the starboard side, and then along the deck to the reel, upon which it was wound. This worked admirably, relieving the reel, which thus became a mere spool, from all strain either in winding up or in dredging, the whole strain being taken up by the ten turns of the wire rope on the surging drum of the main reeling-engine. The arrangements for leading off the wire from the bow of the ship, through a large sheave at the end of the dredging-boom, were practically the same as last year. The steel-spring accumulator was, however, replaced this year by one of car-rubber springs, suspended along the foremast, and to this accumulator was attached the pendant running along the dredging-boom which carried the dredging-pulley. As Lieutenant-Commander Sigsbee is soon to publish, in one of the Coast Survey Reports, a full account of the dredging and sounding apparatus used on board the "Blake," I will not speak in greater detail of our apparatus.

No change was made in our dredges. In the trawls several new forms were tried, but we found that the most satisfactory trawl was of the shape adopted last year, the only important change being the greater height of the runners, — 30″. The bar connecting the runners was used as a frame to stretch a sheet of netting across the whole beam, so as to divide the trawl opening into two halves, each opening into the trap. This enabled us to give a longer lead line to the mouth of the double trawl, without danger of fouling from the lead line of the other side. The only change I could still suggest would be that this lead line should run through rings at the corners of the runners, the strain on the side which fell on the ground would take up the slack of the upper side, and thus increase still further the sweep of the trawl. Our trawl-nets were made much shorter than last year, and for deep work, when so much ooze is always likely to choke the trawl, it would be advisable for a ten-foot beam to have a net of not more than twelve to fifteen feet in length.

We also tried dragging a heavy tow-net rapidly over the ground at great depths, in hopes of catching the more active Crustacea and Fishes; but we found that, after all, no deep-sea machine worked better than a

trawl, which, when moved rapidly over the ground, at the rate sometimes of two to two and a half miles an hour, invariably brought up a fine harvest of Fishes and Crustacea, in addition to the usual contents of the sedentary and more sluggish forms. Although the deep-sea townet was used several times, we never brought up any of the so-called deep-sea Siphonophoræ of Studer, even in localities where they came up on the wire rope.

Captain Sigsbee's new sounding-machine worked admirably, and he has every reason to be entirely satisfied with the improvements he has made upon his former machine.

We carried 6,000 fathoms of new, galvanized steel-wire rope, $1\frac{1}{16}''$ ~~diameter,~~ made by the Roebling Sons' Co., which, owing to its greater pliability, proved even more satisfactory than the wire rope used on the last cruise. The steel-wire rope continued during our whole cruise to give complete satisfaction, and enabled us, as in the previous year, to work with the greatest possible rapidity consistent with safety and with the proper handling of the trawls and dredges.

We usually lowered in deep water at the rate of four to four and a half or five minutes per 100 fathoms, and reeled in at the same rate. In the many places where we found rough or rocky bottom we used a flat bar of six-foot beam, to which rings were attached for fastening tangles and a shot. This bar, with from a dozen to fifteen bundles of tangles, proved perhaps our most effective machine in rough bottoms. It rarely fouled, as the dredges or trawls are so apt to do, when working over unfavorable ground. The region over which we chiefly worked this year extended from St. Thomas to Trinidad. Over a limited area like this it was possible to cover the ground very satisfactorily. The work done off the principal islands began usually at the 100-fathom line, and extended into the deepest water off the lee side of the Caribbean Islands. But little could be done in the way of dredging in the passages between the islands or to the windward of them, owing to the strong trades. While working off Barbadoes we undoubtedly obtained a fair representation of the fauna to the windward of the Caribbean Islands, which does not seem to differ from that of the lee side.

During this season we occupied no less than 200 stations, and made over 230 hauls from the 100-fathom line to the depth of 2,412 fathoms. A few hauls were occasionally made in shallow water, but they formed no part of our regular scheme. Although we have obtained from the West India Islands some of the most interesting Invertebrates, yet we did not find the fauna of the eastern extremity of the Caribbean Sea

materially different from that of the Gulf of Mexico and the Straits of Florida. It certainly is by no means as rich in animal life at great depths. We rarely got from deep water, say between 1,500 and 2,400 fathoms, the rich hauls so invariably made in the Gulf from depths of between 1,200 and 2,000 fathoms. But we found, what was much more important for our success, that the range of the greater number of the deep-sea species extended within very easy dredging limits, and we soon discovered that by dredging mainly between 300 and 1,000 fathoms we obtained, not only nearly all the species extending to the 2,000-fathom line, but obtained them in considerable numbers. This enabled us, of course, to collect a large amount of material, and the collections of this year's cruise combined with those of the previous year, added to the older collections made by Count Pourtalès on the "Bibb," and to those of the Hassler, make our deep-sea collections but little inferior to those of the "Challenger."

I was greatly struck with the large number of our species which, if not identical, are at least closely allied to those brought home by the "Challenger"; and I was specially disappointed at the absence of types not already collected by the great English expedition. I think it can be fairly stated that the great outlines of the deep-sea fauna are now known, and that, although many interesting forms will undoubtedly be dredged in the shallower waters, between 100 and 300 fathoms, we can hardly expect to add materially to the types discovered by the dredging expeditions of the last ten years. As has been well said by Mr. Moseley of the "Challenger," it becomes somewhat monotonous to find constantly the same associations of Invertebrates in the deeper hauls, and it is only in shallower waters that it is possible to keep up one's enthusiasm after a few months' work. I should be inclined, from the experience of the past two years, to carry the range of the deep-sea fauna as high as 300 or 350 fathoms, and to call the littoral fauna the species extending mainly to the 100 or 150 fathom line; from the 100 to the 300 or 400 fathom line extend the species which are neither littoral nor yet have the wide geographical range belonging to species found beyond that depth. But this upper limit of the deep-sea fauna must, of course, depend upon the temperature, and undoubtedly varies greatly from local or partly local causes.

While dredging to the leeward of the Caribbean Islands we could not fail to notice the large accumulations of vegetable matter and of land débris brought up from deep water many miles from the shore. It was not an uncommon thing to find at a depth of over 1,000 fathoms, ten or

fifteen miles from land, masses of leaves, pieces of bamboo, of sugar-cane, dead land shells, and other land débris, which are undoubtedly all blown out to sea by the prevailing easterly trade-winds. We frequently found floating on the surface masses of vegetation, more or less water-logged and ready to sink. The contents of some of our trawls would certainly have puzzled a palæontologist; between the deep-water forms of Crustacea, Annelids, Fishes, Echinoderms, Sponges, etc., and the mango and orange leaves mingled with branches of bamboo, nutmegs, land shells, both animal and vegetable forms being in such profusion, he would have found it difficult to decide whether he had to deal with a marine or a land fauna. Such a haul from some fossil deposit would naturally be explained as representing a shallow estuary surrounded by forests, and yet the depth might have been 1,500 fathoms. This large amount of vegetable matter, thus carried out to sea, seems to have a material effect in increasing, in certain localities, the number of marine forms.

The collections made have all arrived in Cambridge, and will be sent for determination, as fast as practicable, to the naturalists who have undertaken the reports on the different groups of last year's collections. As their preliminary reports are well under way, I need only allude here in general to some of the most interesting types. Among the Foraminifera are a number of the arenaceous types noticed by Mr. Brady in the collections of the "Challenger" and "Porcupine"; among the Sponges, a species allied to Phoronema, a small Hyalonema, tufts of large, silicious spicules (Hyalonema proper), covered at one end with Zoanthus very similar to the common Japanese type; fine series of Dactylocalyx, showing the whole mode of growth from a simple globular form and a gigantic Euplectella. The collection of Starfishes was quite small, and contained nothing worthy of special notice. The collection of Holothurians contained, in addition to the deep-sea forms mentioned in my former letters, a larger number of species than last year, — genera allied to Molpadia, Caudina, Echinocucumis, and the like.

Among the Echini, with the exception of the Pourtalesia group, all the types collected by the "Challenger" are well represented, with a few Spatangoids hitherto unknown. The number of Echinothuriæ was quite large. Of the Pourtalesia group, but few specimens in good condition were obtained, though the trawl brought up numerous fragments of several of the genera (if I am not mistaken) collected by the "Challenger" in deep water in the Southern Ocean. The small number of Clypeastroids collected, even when approaching the South American shore, at the 100-fathom line, near Trinidad, where they are so common,

shows pretty conclusively that the group, with the exception of Echinocyamus, is an eminently littoral one. A large collection of Comatulæ was made, and a number of specimens of Rhizocrinus were obtained, but only a few were in perfect condition. Of Holopus only a part of a specimen was found. It was collected off Montserrat, and escaped my attention, although, of course, on the lookout for black Holopus, I did not notice this imperfect whitish specimen, which must have been alive, among the numerous Pentacrini with which it came up. Our collection of Pentacrini is quite extensive; we found them at Montserrat, St. Vincent, Grenada, Guadeloupe, and Barbadoes, in several places, in such numbers that on one occasion we brought up no less than one hundred and twenty-four at a single haul of the bar and tangles. We must, of course, have swept over actual forests of Pentacrini crowded together much as we find the fossil Pentacrini on slabs. Our series is now sufficiently extensive to settle satisfactorily the number of species of the genus found in the West Indies. There are undoubtedly the two species which have thus far been recognized. It is evident that they vary greatly in appearance, *P. Mülleri* being the most variable. I have nothing to add to the general description of their movements given by Captain Sigsbee in my second letter, with the exception of their use of the cirri placed along the stem. These they move more rapidly than the arms, and use them as hooks to catch hold of neighboring objects, and, on account of their sharp extremities, they are well adapted to retain their hold. The stem itself passes slowly from a rigid vertical attitude to a curved or even drooping position. We did not bring up a single specimen showing the mode of attachment of the stem. Several naturalists, on the evidence of large slabs containing fossil Pentacrini, where no basal attachment could be seen, have come to the conclusion that Pentacrini might be free, attaching themselves temporarily by the cirri of the stem, much as Comatulæ do. I am informed, however, by Captain E. Cole, of the telegraph steamer "Investigator," that he has frequently brought up the West India telegraph cable on which Pentacrini were attached, and that they are fixed, the basal extremity of the stem spreading slightly, somewhat after the manner of Holopus, so that it requires considerable strength to detach them.

The collection of Ophiurans is perhaps the largest ever made. They seem to play a very important part in determining the facies of a fauna. They occur everywhere, at all depths, and often in countless numbers. I hardly think we made a single haul which did not contain an Ophiuran. They often came up when the trawl brought nothing else. In

some places the bottom must have been paved with them, just as the shallows are sometimes paved with Starfishes and Echini, and many species hitherto considered as extremely rare are found to be really abundant. Most, or perhaps all, the deep-sea Atlantic species obtained by the "Challenger" have been rediscovered in large numbers. Such rare species as *Sigsbeia murrhina*, *Ophiozona nivea*, *Hemyeuryale pustulata*, and *Ophiocanax histrix*, were found in plenty. Among the representatives of northern seas may be cited *Astronyx Loveni* (?), while a single specimen of Ophiophyllum represents the great rarities. Of *Astrocnida isidis*, of which only three specimens were known, we have half a dozen. A large Pectinura recalls the shallow fauna of the East Indies, while a new Ophiernus brings to mind the Antarctic deep-sea forms. Finally, the supposed abundance of simple armed Astrophytons is fully confirmed by the various species of Astrochema, and by a new species of Ophiocreas.

The diligent search of Count Pourtalès in the Straits of Florida, the Hassler Expedition, the "Challenger" explorations, and the two expeditions of the "Blake," have evidently brought up the majority of the species of Ophiurans; for among the enormous mass of specimens this time obtained the number of new species is not very great.

The Hydroids and Bryozoa were mainly represented by the same forms as those collected last year, or in former Coast Survey expeditions in the Florida Straits.

The Corals, although abundant in specimens and species, probably contain but few undescribed ones. Very fine specimens of the larger, simple corals obtained by the "Challenger" Expedition, which were never found in our earlier dredgings in the Gulf of Mexico or Straits of Florida, were dredged here, such as Flabellum, Trochocyathus, Ceratotrochus, etc. Several of the deep-sea Actinæ, described by Moseley, were obtained, generally attached to Sponge spicules, Gorgoniæ, or stems of Umbellariæ.

The Alcyonarians were also very abundant, and among them we expect to find many novelties. Little can be said of them at first view, as the deep-water forms have thus far received but little attention. One form, growing in a regular spiral, with equidistant branchlets on the outer side of the spire, seems, by this mode of growth, to differ from anything previously known in that order. Several fine specimens of Umbellaria were obtained.

Among the Annelids, thetubicolous Annelids are by far the most striking, from the exquisite beauty of some of their tubes, composed of

silicious spicules, dead Pteropod shells, and from their strange associations with Corals, Gorgoniæ, Sponges, and even Mollusks. A species of Phorus was frequently accompanied by a large Annelid, comfortably established in the axis of the shell, with the head close to the aperture.

Among the Crustacea, we found again the *Bathyonomus giganteus* A. M. Edw., discovered last year. We also brought up from 734 fathoms a Pygnogonium, measuring not less than two feet along the legs, when fully extended; a fine *Astacus zealacus;* and, from 416 fathoms, a magnificent species, allied to Nephrops, blind, but with rudimentary eye-stalks. An interesting Isopod, with gigantic lateral processes on the posterior segment, was also obtained from 300 fathoms. Many Hermit-Crabs occupied tubes of bamboo or cavities in dead wood and Sponges, of which they completely closed the orifice, with one of the large claws flattened like the operculum of a Serpula.

Among the Mollusks, the preliminary Report of Mr. Dall (in Letter No. 2) mentions the most important types. We obtained, however, in addition, a good set of Pleurotomaria, one specimen measuring five inches in height, while another was so small that the slit, from which the genus takes its name, existed only as a slight indentation. I hope to supply Mr. Dall with the material necessary for an anatomy of this interesting genus. But by far the most interesting of the Mollusks is a Spirula, from a depth of 950 fathoms, in excellent condition. The small number of Waldheimia collected this year is quite striking. Other species of Terebratulæ were more common. We found, as was usual last year, an immense number of dead Pteropod shells at all depths, playing a most important part in determining the nature of the deep-sea bottom.

The collection of Fishes is excellent; its special characteristic is the large number of Lophioid types it contains. We also obtained many of the genera collected by the "Challenger." Some of the rarer pelasgic Fishes, which are occasionally caught at sea, are undoubtedly either full-grown deep-sea Fishes or their young. It becomes an interesting problem to know where the young remain, before they become permanently inhabitants of deep water.

The pelasgic fauna of the eastern part of the Caribbean Sea is, during the winter season, rather scanty. Owing to the constant agitation of the water, I had no opportunity, as in the Gulf, to make much use of the surface tow-net. From the number of fragments of Siphonophoræ constantly found they must be very numerous. In the roadstead, under the lee of the islands, there was but little pelasgic life to be found.

Everything either remains at a short distance below the surface, or is blown out to seaward of the islands. The phosphorescence, in consequence, is far less brilliant than in the Gulf of Mexico, although occasionally the masses of Ctenophoræ (a species of Mnemiopsis), swimming at different depths, produced a very striking illumination: sudden flashes of light suddenly appearing as if coming from great balls of fire floating a short distance below the surface. The most striking phosphorescent phenomena were produced by a small Annelid, allied to Syllis, which moved over the surface of the water with great rapidity, per forming the most remarkable gyrations, and tracing its path, which remained phosphorescent for a short time, by a brilliant line of light. Among the deep-water forms, several of the species of Gorgoniæ and Anthipates (especially Riisea) showed a bright bluish phosphorescence when coming up in the trawl. One Ophiuran also, like one of the Mediterranean species mentioned by Panceri, was exceedingly phosphorescent, emitting along the whole length of its arms at the joints a brilliant, bluish-green light.

One of the most interesting results reached by this year's cruise is the light thrown upon the former extension of the South American Continent, by the soundings taken while dredging, and those subsequently made in the passages between the islands by Commander Bartlett. These, together with the soundings already known, enable us to trace the outline of the old continent with tolerable accuracy, and thus obtain some intelligible, and at the same time trustworthy, explanation of the peculiar geographical distribution of the fauna and flora of the West India Islands. As is well known, Cuba, the Bahamas, Hayti, and Porto Rico, instead of showing, as we might naturally assume from their present proximity to Florida, a decided affinity in their fauna and flora with that of the Southern United States, show, on the contrary, unmistakable association with that of Mexico, Honduras, and Central America; the Caribbean Islands show in part the same relationship, though the affinity to the Venezuelan and Brazilian fauna and flora is much more marked.

In attempting to reconstruct, from the soundings,* the state of things existing in a former period, we are at once struck by the fact that the Virgin Islands are the outcropping of an extensive bank. The greatest depth between these islands is less than 40 fathoms, this same depth being found on the bank to the east of Porto Rico, the 100-fathom line

* See the maps accompanying this letter, for which I am indebted to the Hon. Carlile P. Patterson, Supt. U. S. Coast Survey.

forming, in fact, the outline of a large island, which would include the whole of the Virgin Islands, the whole of Porto Rico, and extend some way into the Mona Passage. The 100-fathom line similarly forms a large plateau, uniting Anguilla, St. Martin, and St. Bartholomew. It also unites Barbuda and Antigua, forms the Saba Bank, unites St. Eustatius, St. Christopher, Nevis, and Redonda. It forms an elongated plateau, extending from Bequia to the southwest of Grenada, and runs more or less parallel to the South American coast from the Margarita Islands, leaving a comparatively narrow channel between it and the 100-fathom line south of Grenada, so as to enclose Trinidad and Tobago within its limits, and runs off to the southeast in a direction also about parallel to the shore line. At the western end of the Caribbean Sea the 100-fathom line forms a gigantic bank off the Mosquito coast, extending over one third the distance from the mainland to the island of Jamaica. The Rosalind and Pedro Banks, formed by the same line, and a few other smaller banks, denote the position of more or less important islands which must have once existed between the Mosquito coast and Jamaica. On examining the 500-fathom line, we thus find that Jamaica is only the northern spit of a gigantic promontory, which once extended toward Hayti from the mainland, reaching from Costa Rica to the northern part of the Mosquito coast, and leaving but a comparatively narrow passage between it and the 500-fathom line encircling Hayti, Porto Rico, and the Virgin Islands, in one gigantic island. The passage between Cuba and Jamaica has a depth of 3,000 fathoms, and that between Hayti and Cuba is not less than 873 fathoms, the latter being probably an arm of the Atlantic. The 500-fathom line connects, as a gigantic island, the banks uniting Anguilla to St. Bartholomew, Saba Bank, the one connecting St. Eustatius to Nevis, Barbuda to Antigua, and from thence extends south so as to include Guadeloupe, Marie-Galante, and Dominica. This 500-fathom line thus forms one gigantic island of the northern islands, extending from Saba Bank to Santa Cruz, and leaving but a narrow channel between it and the eastern end of the 500-fathom line running round Santa Cruz. As Santa Cruz is separated from St. Thomas by a channel of forty miles, with a maximum depth of over 2400 fathoms, this plainly shows its connection with the northern islands of the Caribbean group, rather than with St. Thomas, as is also well shown by the geographical relations of its Mollusca. The 500-fathom line again unites, in one gigantic spit extending northerly from the mouth of the Orinoco, all the islands to the south of Martinique, leaving Barbadoes to the east, and a narrow passage between Martinique and the islands of Dominica and St. Lucia.

At the time of this connection, therefore, the Caribbean Sea connected with the Atlantic only by a narrow passage of a few miles in width between St. Lucia and Martinique, and one somewhat wider and slightly deeper between Martinique and Dominica, another between Sombrero and the Virgin Islands, and a comparatively narrow passage between Jamaica and Hayti. The Caribbean Sea, therefore, must have been a gulf of the Pacific, or have connected with it through wide passages, of which we find the traces in the Tertiary and Cretaceous deposits of the Isthmus of Darien, of Panama, and of Nicaragua. Central America and northern South America at that time must have been a series of large islands with passages between them from the Pacific into the Caribbean. It is further interesting to speculate what must have become of the great equatorial current, or rather of the current produced by the northeast trades. The water banking up against the two large islands, then forming the Caribbean Islands, must, of course, have been deflected north, have swept round the northern shores of the Virgin Islands, Porto Rico, and Hayti, and poured into the western basin of the Caribbean Sea, through the passage between Hayti and Cuba. This water being forced into a sort of funnel, by the 500-fathom line forming the southern line of the Great Bahama Island, which connected nearly the whole of the Bahamas with Cuba and formed a barrier to the western flow of the equatorial current, this must, therefore, for the greater part, have been deflected north, and either swept in a northeasterly direction, as the Gulf Stream now does, or round the north end of the Bahamas, across Florida, which did not then exist, across the Gulf of Mexico, and into the Pacific over the Isthmus of Tehuantepec. To Commander Bartlett's interest in this subject I am indebted for the first information respecting the lines run between the islands: —

Extract from Letter of Commander J. R. Bartlett, U. S. N.

"I connected the islands by running traverses across the ridges. From St. Vincent to St. Lucia the ridge was only from 150 to 170 fathoms below the surface, with a channel of 400 fathoms near St. Vincent. The channel between St. Lucia and Martinique had 500 fathoms in mid-channel, sloping upward to each island. The channel between Martinique and Dominica was a tough one, and I thought I should never find a ridge. The soundings increased regularly on a ridge to 300 fathoms in mid-channel, where I got a sounding of 883 fathoms, and then 1,000 fathoms; beyond this the ridge was some ten miles to the westward, with an average depth of 400 fathoms, but I found two peaks with only 40 fathoms. The deep water from the Caribbean Sea makes in between Guadeloupe and Montserrat, but I found a ridge of about 300 fathoms connecting Antigua with Guadeloupe. In this channel I also found a peak with only forty fathoms. I finished up the line connecting Saba

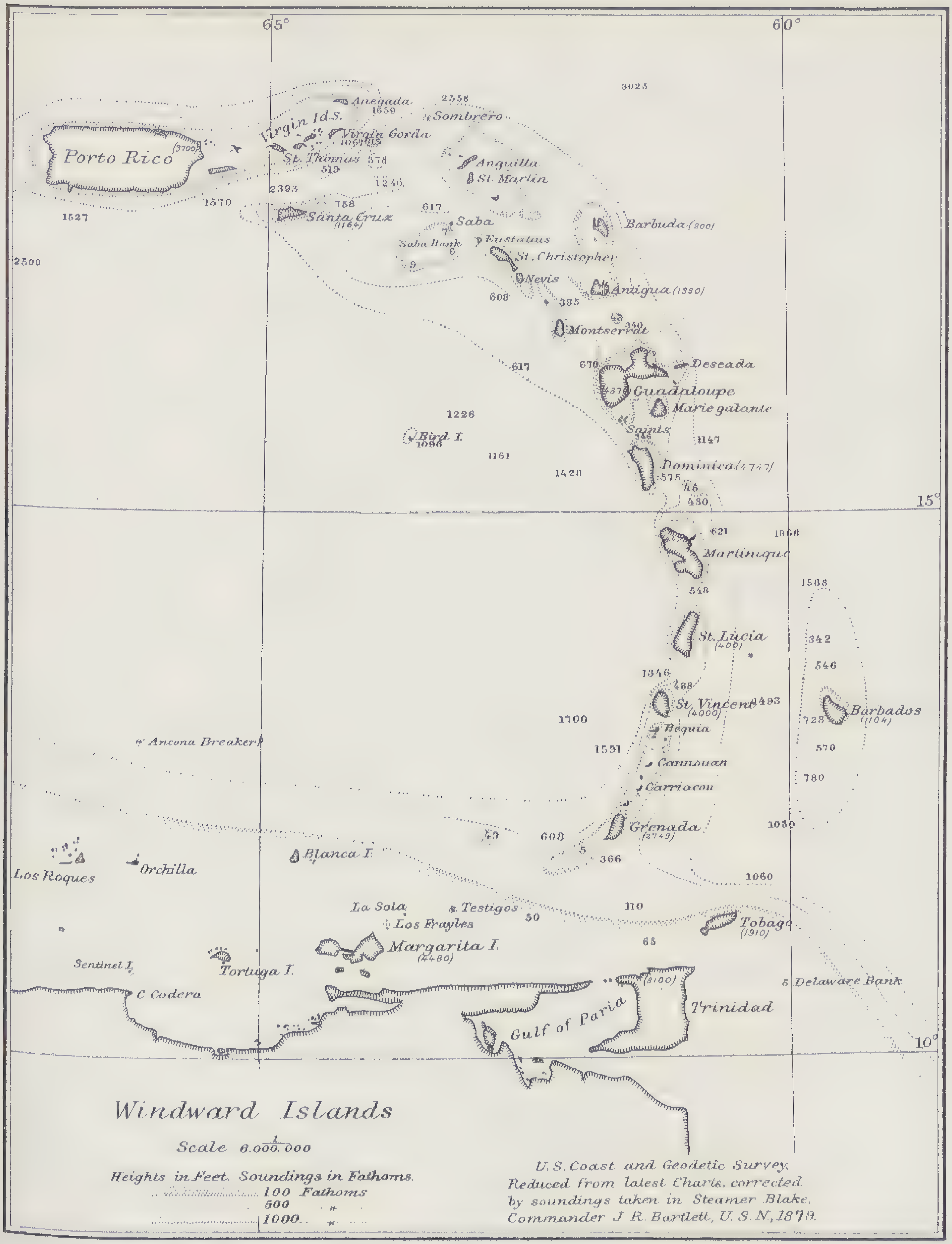
Bank with St. Croix. I found the connection perfect, but the ridge has 700 fathoms water on it near St. Croix. There is 1,000 fathoms three miles north, and 1,800 fathoms five miles south of the ridge. I ran a line from Dog Island to White House Shoal, and back to Sombrero. Here I found a channel about ten miles wide, with 1,100 fathoms. The temperature was 38° at 1,100; outside 37½° at 1,600, and 36½° at 2,500. I shall run a number of lines from St. Thomas to Sombrero, to be sure that this channel connects with the deep water off St. Thomas. I ran a line of soundings from the south end of Dominica to Avis Island. The soundings were regular at 1,000 fathoms, to within ten miles of Avis Island."

The soundings made by Commander Bartlett, after I left the "Blake," to determine the ridges uniting the various islands between Sombrero and Trinidad, show plainly that the cold water of the Caribbean can only come in through the passage between Sombrero and the Virgin Islands, which is about 1,100 fathoms, with a bottom temperature of 38°, while the 500-fathom line, as I have said, forms a gigantic island of all the islands to the south of Sombrero, including Dominica, with a narrow passage of 1,000 fathoms between it and Martinique; the 500-fathom line again uniting into one large spit, as a part of South America, all the islands to the south of it. Thus the bulk of the water forced into the Caribbean Sea has a comparatively high temperature, — an average, probably, of the temperature of the 300-fathom line. The cold water of the Atlantic is, however, again forced into the western basin of the Caribbean through the Windward Passage, and all this through the Yucatan Channel, between Cape San Antonio and the Yucatan Bank. It is, therefore, incredible that with this huge mass of water pouring into the Gulf of Mexico, there should be anything like a cold current forcing its way up-hill into the Straits of Florida, as has been asserted on theoretical grounds. The channel at Gun Key can only discharge the surplus by having a great velocity.

Mr. Garman, who as usual accompanied me, remained in the West Indies, after we left the "Blake" at Barbadoes, for the purpose of making collections of Reptiles and Fishes, with a view of throwing additional light on the former connections of the islands, as I have here attempted to trace it. One of the most interesting of the Reptiles we collected is a gigantic land tortoise, found at Porto Rico, differing only in size from the land turtle still found on Trinidad and adjoining parts of South America. It is closely allied to the gigantic turtles of the Gallopagos, and to the fossil land turtles, of which fragments have been described by the late Professor Wyman. These were collected by Mr. A. Julien at Sombrero, in the phosphate beds of the island.

CAMBRIDGE, May 10, 1879.

Caribbean Sea
Scale 1/10.000 000
Gulf of Mexico
Tortugas
Florida Strait
Yucatan Bank
Yucatan Channel
Yucatan
Cozumel I.
Chinchorro Bk.
Turneffe I.
Belize
Gulf of Honduras
Bay Ids.
Honduras
Mosquito Coast
San Juan R.
Costa Rica
Chiriqui Lagoon
Gulf of Columbus
Panama
Aspinwall
G. of St. Blas
Panama Bay
Gulf of Darien
Magdalena
Gulf of Venezuela
Venezuela
Orinoco
Cuba
Nicolas Chl.
Santaren Chl.
Great Bahama Bank
Old Bahama Ch'l
Tongue of the Ocean
Andros Ids.
New Providence
Eleuthera I.
Exuma Sound
Cat I.
Bahama Ids.
S. Salvador
Rum I.
Long I.
Crooked I. Passage
Samana Cay
Crooked I.
Planas Cay
Mariguana I.
Acklins I.
San Domingo Cay
Hogsty Rf.
Caicos Ids
Turks I.
Turks I. Passage
Inagua I.
Mouchoir Carré Bank
Silver Bank
Navidad Bank
Pickle Bk.
Little Cayman
Grand Cayman
Ministeriosa
Windward Passage
Tortuga
San Domingo
Formigas Bk.
Jamaica
Swan Ids.
Pedro Bk.
Morant Cays
Rosalind Bk.
Baxo Nuevo
Serranilla Bk.
Serrana Bk.
Roncador Bk.
Old Providence
St. Andrews
Courtown Bk.
Albuquerque Cays
Mona Passage
Mona
Porto Rico
Virgin Ids.
Santa Cruz
Sombrero
Anguilla
Barbuda
St. Christopher
Antigua
Montserrat
Guadaloupe
Marie galante
Saints
Dominica
Bird I.
Martinique
St. Lucia
St. Vincent
Barbados
Grenada
Tobago
Trinidad
Delaware Bk.
Windward Ids.
Leeward Ids.
Ancona Breaker
Oruba I.
Curaçoa I.
Buen Ayre
Aves Ids.
Los Roques
Orchilla
Blanca I.
Testigos
La Sola
Los Frayles
Margarita I.
Tortuga
Heights in Feet.
Soundings in Fathoms.
100 Fathoms.
500
1000
U.S. Coast and Geodetic Survey.
Reduced from latest Charts, corrected by soundings taken in Steamer Blake.
Commander J. R. Bartlett, U.S.N., 1879.
85°
75°
70°
65°
60°
20°
15°
10°


65°
60°
15°
10°
Porto Rico (3700)
Virgin Ids.
Anegada
Virgin Gorda
St. Thomas
Sombrero
Anguilla
St. Martin
Santa Cruz (1164)
Saba
Saba Bank
Eustatius
St. Christopher
Nevis
Barbuda (200)
Antigua (1330)
Montserrat
Deseada
Guadaloupe
Marie galante
Saints
Dominica (4747)
Bird I.
Martinique
St. Lucia (4001)
St. Vincent (4000)
Bequia
Cannouan
Carriacou
Grenada (2749)
Barbados (1104)
Tobago (1910)
Trinidad
Gulf of Paria
Delaware Bank
Ancona Breakers
Los Roques
Orchilla
Blanca I.
La Sola
Testigos
Los Frayles
Margarita I. (4480)
Tortuga I.
Sentinel I.
C Codera
Windward Islands
Scale 1/6.000.000
Heights in Feet. Soundings in Fathoms.
100 Fathoms
500
1000
U.S. Coast and Geodetic Survey.
Reduced from latest Charts, corrected
by soundings taken in Steamer Blake,
Commander J. R. Bartlett, U. S. N., 1879.

No. 15. — *On the Development of* PALÆMONETES VULGARIS.
By WALTER FAXON.

THE observations recorded in this paper were made during the summers of 1876 and 1877 in the laboratories of Mr. Alexander Agassiz, at Newport, R. I., and of the United States Commission of Fish and Fisheries, at Wood's Hole, Mass. I am under great obligations to Mr. Agassiz, and Professor S. F. Baird, United States Commissioner of Fish and Fisheries, for placing at my disposal every means for the collection and study of specimens.

The difficulty of rearing the larvæ of *Crustacea* in confinement, and the uncertainty of finding all the stages in the development of a species by collecting with the hand-net or tow-net, perhaps account for the fact that we have so few life-histories of Decapod *Crustacea* which are in any way complete.

The common prawn of our coast, *Palæmonetes vulgaris* Stimpson, is one of the most typical of the long-tailed Decapods, and affords an excellent opportunity for obtaining the life-history of a Macrouran, which undergoes a metamorphosis after quitting the egg. The present paper is a contribution to that history.

The opacity of the eggs and larvæ making it impossible to follow the development of the internal organs in detail, I have confined myself chiefly to the growth of the hard parts.

This species was first described by Say, in 1818, under the name of *Palæmon vulgaris;* * again described, and figured for the first time, by De Kay, in 1844.† In 1869, the genus *Palæmonetes* was established by Heller for the reception of *Palæmon varians* Leach, from the North Sea and fresh waters of the Mediterranean basin.‡ It differs from *Palæmon* in lacking mandibular palpi. In the armature of the carapace it agrees with *Palæmon*, subgen. *Leander*, i. e. an antennal and a branchiostegal spine are present, but no hepatic spine.

* An Account of the *Crustacea* of the United States. Jour. Acad. Nat. Sci. Phila., Vol. I. pp. 248, 249. 1818.

† Zoölogy of New York, Part VI. Crustacea, pp. 29, 30, Pl. IX. Fig. 30. 1844.

‡ Zur näheren Kenntniss der in den süssen Gewässern des südlichen Europa vorkommenden Meerescrustaceen. Zeitschr. wissensch. Zool., Vol. XIX. p. 160. 1869.

Our species was properly placed in the genus *Palæmonetes* by Stimpson in 1871.*

A figure of the adult, by J. H. Emerton, is given on Plate II. of Verrill and Smith's "Report upon the Invertebrate Animals of Vineyard Sound and the Adjacent Waters," and on page 235 of the same work is a description of the first larval stage by Smith.†

This species is common in shallow water along the eastern coast of the United States from Hampton, N. H. (! Coll. Mus. Comp. Zoöl.), to the St. John's River, Fla. (G. Brown Goode). It is especially common on sandy bottoms among the eel-grass, where, as Verrill well observes, its color admirably adapts it for concealment.‡ It ascends far up into the brackish water of estuaries and rivers. I have found it abundant in the Charles River marshes, Cambridge, Mass., and Mr. G. Brown Goode collected it in the St. John's River, Fla., twenty-two miles from the mouth, where the water was perfectly fresh to the taste.§ On the coast of New Jersey and the Carolinas it is associated with a nearly allied species, *Palæmonetes Carolinus* Stimpson.‖ It is represented in the fresh waters by a smaller and slenderer species, *Palæmonetes exilipes* Stimpson,¶ which has a wide distribution in the rivers and lakes of the Western and Southern States.

* Notes on North American *Crustacea* in the Museum of the Smithsonian Institution, No. III. Ann. Lyc. Nat. Hist. N. Y., Vol. X. p. 129. 1871.

† Report on the Condition of the Sea Fisheries of the South Coast of New England in 1871 and 1872, p. 529, Pl. II. Fig. 9. 1873. The description of the larva also appears in Smith's "Early Stages of the American Lobster (*Homarus Americanus* Edwards)." Trans. Conn. Acad., Vol. II. p. 377. 1873.

‡ *Op. cit.*, p. 479.

§ *Vide* S. I. Smith's "Stalk-eyed Crustaceans of the Atlantic Coast of North America north of Cape Cod." Trans. Conn. Acad. Arts and Sci., Vol. V. p. 37. 1879.

‖ *Op. cit.*, p. 129.

¶ *Op. cit.*, p. 130. This is probably the species described, from imperfect specimens, under the name of *Hippolyte paludosa*, by Gibbes, in 1850 (On the Carcinological Collections of the Cabinets of Natural History in the United States. Proc. Amer. Ass. Adv. Sci., 1850, p. 197), as claimed by Kingsley (Notes on the North American *Caridea* in the Museum of the Peabody Academy of Science at Salem, Mass. Proc. Acad. Nat. Sci. Phila., 1878, p. 97).

I observe in an ovigerous female of this species from Kentucky, preserved in alcohol, that the eggs are much larger in size and fewer in number than those of *Palæmonetes vulgaris.* While the eggs of the latter, shortly after laying, measure about .5 mm. in long diameter, those of the former (the embryo has seemingly hardly begun to form) measure 1.25 mm. in length. Whether the fresh-water *Palæmonetes* hatches from the egg in a more advanced phase of development than its marine rela-

In June, July, and the early part of August, the females of *Palæmonetes vulgaris* may be found carrying their eggs (which will afford different phases of development in different individuals simultaneously) fixed to the hairs on the peduncle * of the abdominal appendages, from the first to the fourth pair inclusive. Here they receive not only the protection of the parent, but also a constant aëration by means of the gentle backward and forward movement of the abdominal appendages. This aëration of the eggs seems to be essential to their development, for if detached from the mother they invariably die, unless the enclosed embryo has very nearly reached the point of hatching.

All the eggs are not attached directly to the appendages of the abdomen, as in *Astacus*, but many of them are joined to one another by delicate threads drawn out from the secretion which invests each egg. Thus large clusters are formed, in which comparatively few eggs are fixed immediately to the abdominal appendages. These clusters, again, are different from the botryoidal clusters so common among the *Brachyura*, in which the eggs are only indirectly connected with each other through the mediation of a common stalk from which the eggs depend by short pedicels.

Soon after the escape of the young the parent prawn casts her integument, thus ridding herself of the egg-shells which are indissolubly fastened to her legs. I have found this moult to take place almost invariably within a few hours after the hatching of the eggs.† Commonly this happens in the night, morning discovering the newly-hatched brood of zoëæ collected at the surface of the aquarium, on the side toward the light, and the discarded integument of the parent prawn sunk to the bottom. I have never seen the prawn practise that economy observed in certain insect larvæ, which devour their cast-off skin.

The newly-laid eggs are elliptical, about .5 mm. in long diameter.

tive, is an interesting question for our Western zoölogists to answer. The young of the fresh-water *Caridina Desmarestii*, as we know from the observations of Joly (Études sur les Mœurs, le Développement et des Métamorphoses d'une petite Salicoque d'Eau Douce (*Caridina Desmarestii*). Ann. Sci. Nat., 2d series, Vol. XIX. 1843), are hatched as zoëæ, and undergo a subsequent metamorphosis before attaining the adult form.

* Not to the *inner branches*, as is stated to be the case with *Palæmon serratus*, by J. V. Thompson (Memoir on the Metamorphoses in the *Macrouræ* or Long-tailed *Crustacea*, exemplified in the Prawn (*Palæmon serratus*). Edinburgh New Philosophical Jour., Vol. XXI. p. 223. 1836).

† Joly observed the same thing in *Caridina Desmarestii* (*op. cit.*, p. 55).

The gluey secretion which attaches the eggs to the abdominal limbs of the mother hardens into a structureless membrane, which invests each egg so closely that it is difficult to separate it from the proper egg-membrane. The yelk is of a greenish color, heavily charged with deutoplasmic elements in the shape of minute granules and larger spherical vesicles, intermixed with oil-globules.

The cleavage of the egg begins in two planes almost simultaneously. These planes are at right angles with each other, passing through the long and the short axes of the egg. The egg is thus divided into four cleavage-spheres, each provided with a nucleus and nucleolus. Delicate lines of protoplasm extend like rays from the nuclei into the surrounding yelk (Pl. I. Fig. 1).

The opacity of the eggs prevented my determining whether the cleavage passed completely through the yelk.*

The cleavage proceeds regularly (Plate I. Fig. 2), forming eight, six-

* Bobretzky, who has made sections of the eggs of *Palæmon*, is uncertain how deep the clefts enter the yelk in the earliest stages of segmentation, owing to the imperfection of his sections. (On the Embryology of Arthropods [in Russian]. Zapiski Kiefs. Obshtshest. Yestestvoispitatalyei, Vol. III. p. 190. 1873. A short and unsatisfactory abstract of Bobretzky's paper, in German, by Hoyer, appears in Hofmann and Schwalbe's "Jahresberichte," Vol. II. pp. 312–318. 1875. I have had certain parts of the original paper translated from the Russian for me by Mr. Ivan Panin.) By the time that 128 cleavage products are formed they have the shape of long pyramids, whose apices are fused in the common undivided granular mass at the core of the egg, while the clear protoplasm, involving the nuclei, collects at the surface of the egg, in the bases of the pyramids. Later the boundaries of the pyramids become obliterated, and their protoplasmic bases thus form a cellular superficial blastoderm, enclosing the opaque nutritive yelk (Pl. V. Fig. 18 *et seq.*).

In *Crangon vulgaris*, according to E. Van Beneden (Recherches sur la Composition et la Signification de l'Œuf. Mém. Cour. Acad. Roy. Belg., Vol. XXXIV. p. 142, Pl. X. Fig. 20. 1870), the cleavage is at first total, then a separation takes place between the deutoplasm and the protoplasm of the vitelline segments; the former accumulating at the centre of the egg, the latter, carrying with it the nuclei of the segments, is borne to the periphery to constitute the cells of the blastoderm.

The egg of *Peneus* (*membranaceus?*), as observed by Haeckel (Die Gastrula und die Eifurchung der Thiere. Jenaische Zeitschr. f. Naturwissenschaft, Vol. IX. pp. 447, 448, Pl. XXIII. Fig. 82), in the stage with four cleavage-cells, showed on cutting that the furrows extended less than half-way to the centre of the egg, leaving a large, elliptical, central mass of nutritive yelk undivided.

In *Eupagurus Prideauxii*, as we learn from P. Mayer (Zur Entwicklungsgeschichte der Dekapoden. Jenaische Zeitschr. f. Naturwissenschaft, Vol. XI. p. 212, Pl. XIII. 1877), eight segments, completely separated from one another, are formed before the segregation of the deutoplasm from the protoplasm begins.

teen, thirty-two segments, and so on, until the whole surface of the egg is made of minute, polygonal cells (perimorula). No polar globules are emitted.*

Twenty-four hours after the cleavage began, an egg was found in the gastrula-stage, as represented on Plate I. Fig. 3. The cavity is very small compared with the size of the egg, and its orifice (g) is bounded by elliptical cells, which form a light-colored disk on the surface of the egg. The orifice apparently closed a little later, and the further history of the cavity was not obtained.

The yelk now shrinks away from its membrane in the vicinity of the light-colored disk, and becomes transparent and free from granules preparatory to the appearance of the parts of the embryo.

The parts of the embryo which first appear are the abdomen, the labrum and cephalic disks, and the first three pairs of appendages. These appear almost simultaneously. A protuberance from the surface of the yelk, near the place where the gastrula opening appeared, is the rudiment of the abdomen. Another fold over against the first is the beginning of the formation of the labrum, and in front of this two disks appear, which are the first trace of the eyes and front part of the head of the embryo.

The projection of the two folds which form the abdomen and labrum is such that the free ends are toward one another. Thus the abdomen, from the time of its earliest appearance, is bent forward underneath the breast of the future prawn. On each side of the labrum and abdomen are three lobes, which are the rudiments of the two pairs of antennæ and the mandibles. The first pair are on a level with the labrum, the third pair with the end of the abdomen. All three pairs are simple. This is the nauplius-stage of the embryo.†

* P. Mayer observed occasionally in fresh-laid eggs of *Eupagurus* "a sort of *Richtungsbläschen*," but he considers these cases abnormal. They were probably the result of disintegration of the egg (*op. cit.*, p. 223).

† Joly's account of the order of appearance of the appendages of the embryo of *Caridina*, — first, the three pairs of thoracic legs (i. e. the maxillipeds), then the maxillæ, mandibles, and antennæ, — is without doubt incorrect (*op. cit.*, pp. 59, 60). In an abstract of a paper "On the Development of the Crustacean Embryo, and the Variations of Form exhibited in the Larvæ of 38 Genera of Podophthalmia" (Proc. Royal Soc. London, Vol. XXIV. p. 378. 1876), Spence Bate states his belief "that he has demonstrated that the three pairs of mobile appendages in the cirripedal or *Nauplius* form of larva homologize with the eyes and two pairs of antennæ, and not with the antennæ and mandibles, as stated by Fritz Müller, Anton Dohrn, and others." (!) It is to be hoped that the evidence will not long be withheld from publication.

The appendages back of the mandibles now appear in regular succession in the form of hyaline protuberances from the opaque yelk. Four days after the gastrula-stage (Pl. I. Fig. 3), the embryo has the form portrayed on Plate I. Fig. 4.

The rudiments of the appendages have appeared as far back as the sixth pair (first pair of maxillipeds). The second pair of antennæ (Pl. I Fig. 4, *II*), are now double appendages, the two parts representing the flagellum and scale of the future antenna. The appendages behind the mandibles are bilobed from the time of their earliest appearance. The labrum (*l b*) has moved backward, so as now to lie on a line with the second pair of antennæ.

The antennæ rapidly increase in length, assuming the form of ribands which lie along the outer side of the following appendages, parallel with the abdomen. Three days after the stage last described they reach as far back as the first pair of maxillipeds (Pl. I. Fig. 5). The first pair (*I*) lie on the outer side of the second pair (*II*), and are slightly shorter than these. The outer branch of the second pair, again, is a little longer than the inner branch. Even at this early period traces of setæ are seen on the extremities of both pairs of antennæ. The rudiments of the appendages are now formed as far back as the third pair of maxillipeds (Pl. I. Fig. 5, *VIII*), the abdomen (*a b*) extends forward so far as to meet the labrum (*l b*), but is still unformed along the median dorsal line. Some scattered blotches of a dark color (*o c*) are the first indications of the pigment of the compound eye.*

On the following day (Aug. 5) I observed the first appearance of the median simple eye in the form of a black pigment-spot in the middle line of the head.

The embryo gradually encroaches upon the unabsorbed yelk-mass on the dorsal side of the egg. The outline of the carapace (Pl. I. Fig. 6, *c p*, four days before hatching) comes into view, extending posteriorly beyond the third pair of maxillipeds. Under the posterior part of the carapace the heart appears as a transparent pulsating sac (*h t*). The abdomen (*a b*) becomes divided into segments by transverse constrictions which begin on the ventral side, the side which is applied to the ventral face of the cephalo-thorax of the embryo. Within the abdomen are seen the ganglia of the nervous system (Pl. I. Fig. 6, *n g*). The end of the abdomen is produced into two blunt lobes, on the borders of which the setæ are already visible.

* The development of the eye certainly lends no countenance to the view that its stalk is an appendage homologous with the antennæ, etc.

Plate I. Fig. 8, represents an embryo further advanced. The abdomen has lengthened to such an extent that it entirely conceals the labrum, and extends forward so as to almost meet the tip of the rostrum (*r s*), which lies bent beneath the head. The maxillipeds have increased in length, and extend forward as two-branched appendages on each side of the abdomen. At the base of the rostrum is the simple median eye (*o c l*); the permanent eyes (*o c*) show through the egg-shell as oval black spots.

In the still older embryo in the egg represented on Plate I. Fig. 9, the unabsorbed yelk (*v t*) has so diminished as to appear as a large greenish patch on the dorsal side of the embryo. The whole margin of the carapace is clearly defined, and its posterior or cardiac portion is unobscured by underlying yelk. The eyes (*o c*) now form two black roundish spots at the anterior end of the embryo, so large that they are very conspicuous to the naked eye. The corneæ and cones are now formed, and the eye is thrust out a little upon a very short stalk. The antennæ of the first pair (*I*) are divided into two segments, a long proximal and a short oval distal one. The latter is furnished with a few setæ at its tip. The two branches of the second antennæ (*II*) are also tipped with setæ.

In the course of the development of the embryo within the egg, the egg has become larger than it was when first laid. A few hours before hatching (Pl. I. Fig. 10), it measures 1 mm. in long diameter. A small patch of yellowish green (*v i t*) just behind the eyes is the only remnant of the unabsorbed yelk. The abdomen (*a b*) has lengthened to such an extent that it reaches far beyond the mouth, between the eyes, to the dorsal side of the head. The basal segment and the two branches of the second pair of antennæ are now clearly defined, and have acquired very nearly the form which they have in the larva after hatching. The maxillipeds have grown to a very large size, and conceal the oral appendages in front of them.

Embryos removed from the egg an hour before hatching (Pl. I. Fig. 11) disclosed two pairs of two-branched sac-like appendages (Figs. 11, 13, *IX*, *X*), concealed between the bases of the third maxillipeds. These are the rudiments of the two pairs of chelipeds of the adult prawn. The structure of the embryo is now the same as during the first larval stage.

First Larval Stage (Pl. I. Figs. 14–18; Pl. II. Fig. 1). — When it first issues from the egg the young prawn is $2\frac{1}{3}$ mm. in length. The carapace is broad, produced between the eyes into a long, pointed rostrum. At the base of the rostrum is a small simple eye. The com-

pound eyes are of huge dimensions, and supported upon short, thick stalks. The abdomen is composed of six segments only, the telson being not yet clearly separated from the preceding segment. The width of the abdomen suddenly diminishes at the fourth segment. The sixth segment consists of a long, cylindrical piece, which terminates in a broad, triangular fin. The hind border of the terminal fin is slightly convex, the angles truncated and notched. It is armed with fourteen long setæ, which are finely feathered on both sides, excepting the outer two pairs, which are feathered only on the inner side. The spaces between the long setæ are slightly concave, and furnished with about four very minute setæ (Pl. I. Fig. 18).* The anus lies on the lower side of the base of the terminal fin, and the intestine shows through the transparent shell as a slender tube passing in a direct line from the stomach to the anus.

The first pair of antennæ (Pl. I. Fig. 15) are short, simple, composed of a large basal segment followed by a small, oval, setiferous, terminal segment. The distal end of the proximal segment also bears a long seta on the inner side of, and longer than, the terminal segment.

The second pair of antennæ (Pl. I. Fig. 16) are about as long as the first pair. They are composed of a short basal segment which bears two branches. The inner branch (*r i*), which develops into the flagellum of the second pair of antennæ in the adult, is a slender piece tipped with a long seta. The outer branch (*r e*), which represents the "scale," is at this stage much larger than the inner, divided into segments for some distance from its tip, and furnished with setæ on its inner border.

The mouth is bounded in front by a large, prominent, triangular labrum (Pl. I. Fig. 17, *l b*). The mandibles (Pl. I. Fig. 17, *III*) are slender, and taper gradually to the tips, which are armed with three teeth. There is no trace of a mandibular palpus at any stage in the development.

The first pair of maxillæ (Pl. I. Fig 17, *IV*), consist of two lobes, the outer of which bears a one-jointed palpus. Both lobes, as well as the palpus, are furnished with setæ on their borders.

The second pair of maxillæ (Pl. I. Fig. 17, *V;* Fig. 12) are composed of an inner plate, the inner edge of which is divided into five lobes, and an outer plate, the scaphognathite, which lies under the carapace and projects far beyond the inner plate toward the eye-stalk. All the lobes are beset with setæ. The scaphognathite is in constant motion,

* The caudal fin of the first zoëa-stage of *Palæmon serratus* is figured by P. Mayer (*op. cit.*, Jena. Zeitschr., Vol. XI. Pl. XV. Fig. 49).

baling the water out from the branchial chamber before the least trace of the gills has appeared. As the currents of blood in the zoëa stream along the sides of the carapace, they are aërated through the delicate integument by the constant flow of water kept up by the movement of the scaphognathite, which thus plays the same part as in the gill-bearing adult.

Next follow the three pairs of maxillipeds, which, in the early stages of development, serve as swimming-organs. The first pair is the smallest. Its basal segment (Pl. I. Fig. 17, *VI*) has a strongly convex inner margin, which is beset with setæ. This part of the limb acts as a jaw, while the rest of the limb is used for locomotion. In this the appendage recalls the structure of the limbs in the *Merostomata*. The inner branch is composed of one segment. The outer branch (Pl. I. Fig. 14) is obscurely divided into two segments, and is considerably longer than the inner branch.

The second pair of maxillipeds (Pl. I. Fig. 14, *VII*) consist in like manner of a basal segment and two branches. The inner branch consists of three segments, of which the proximal and middle are of about equal length, the distal very short. The outer branch is longer than the inner, and is indistinctly divided into five or six segments. Of these the first and second are of equal length, and form together the bulk of the branch. The following segments are crowded together near the tip of the branch, and the lines of division between them can barely be discerned.

The third pair of maxillipeds (Pl. I. Fig. 14, *VIII*) exceed the second pair in length, but have essentially the same structure. The second pair, again, are longer than the first pair. The branches of all the maxillipeds are furnished with long setæ.

Behind the third pair of maxillipeds are seen the rudiments of the two following pairs of thoracic appendages (Pl. I. Figs. 14, 17, *IX*, *X*; Fig. 13). They are two-branched, each branch having the form of a simple sac, without trace of a division into segments.*

There are as yet no traces of abdominal appendages.†

* Du Cane (Ann. Nat. Hist., Vol. II. Pl. VI. Fig. 2. 1839) and Bobretzky (*op. cit.*, p. 204, Pl. V. Fig. 17) both represent the first larval stage of *Palæmon* with the rudiments of the first *three* pairs of walking-feet in the form of *simple* sacs. I am inclined to believe that a more careful dissection would have revealed, in both cases, the structure which I have found in *Palæmonetes vulgaris*, viz. *two* pairs of *double* sacs.

† According to Kröyer (Monografisk Fremstilling af Slægten Hippolyte's nordiske

Just behind the eye-stalks, on the front part of the carapace, are two large blotches of dark pigment. Two similar pigment-spots are seen in most individuals on the hinder part of the carapace, and one in the median line of the body on the dorsal side of the second abdominal segment. The distribution of pigment-spots varies considerably, however, in different individuals.

Second Larval Stage (Pl. II. Figs. 2 – 4). — After the first moult the larva measures 3 mm. from the tip of the rostrum to the end of the abdomen. It now has the the same general shape as in the preceding stage, but the carapace is provided with a dorsal spine which is directed forward at the base of the rostrum, and a lateral spine on each side, on the anterior margin. This spine is the supra-orbital of Stimpson's nomenclature.* The posterior margin of the fifth abdominal segment is produced into a tooth-like process on each side.

The first pair of antennæ have acquired an additional (third) segment, but are still simple.

The second pair of antennæ are of the same shape as in the first larval stage, as are also the mandibles and maxillæ.

The maxillipeds have increased in length, and the second and third pairs are longer in proportion to the first pair than they were in the foregoing stage. The first pair have gained a segment in both the inner

Arter. Kongel. Dansk. Vidensk. Selsk. naturvid. og mathem. Afhandl. IX Deel, pp. 245 – 251, Tab. VI. Figs. 120 – 132. 1849), the young of *Hippolyte polaris* extracted from the egg have the five pairs of walking-feet in the form of small, simple, jointed appendages, the first pair with the chela already formed. Five pairs of double abdominal limbs are also present, but no sign of the sixth or posterior pair.

We thus see among the *Caridea* a very great difference in the degree of development in which the larvæ leave the egg. At one extreme we have *Peneus* quitting the egg as a nauplius (Fritz Müller, Die Verwandlung der Garneelen. Arch. f. Naturg., Vol. XXIX. pp. 8 – 23, Taf. II. 1863), at the other *Hippolyte*, provided with all the appendages of the adult excepting the last abdominal. Here the walking-feet are simple from the first, and the larva does not pass through a Schizopod stage. Between these extremes are larvæ like those of *Caridina* (Joly), *Palæmonetes*, etc., which hatch with appendages developed as far back as the third pair of maxillipeds inclusive, or the second pair of walking-feet, and which pass through a *Mysis*-state.

It is to be observed, however, that in the larva doubtfully referred to *Hippolyte* by Claus (Untersuchungen zur Erforschung der Genealogischen Grundlage des Crustaceen-Systems, pp. 44, 45, Figs. 14 – 18. 1876), the rudiments of the walking-feet appear subsequently to the earliest larval stage, — first the two anterior pairs simultaneous with the swimmerets (the earliest to appear of the abdominal limbs), then the three following pairs. Here all the walking-feet of the adult are split-feet in the larva.

* Prodromus Descriptionis Animalium Evertebratorum, etc. Proc. Acad. Nat. Sci. Phila., 1860, p. 24.

and outer branches, which are now two- and three-jointed respectively. The second and third pairs retain the same number of segments as before.

The anterior of the two pairs of double sac-like appendages, which lay behind the third pair of maxillipeds in the last stage, have disclosed a pair of two-branched swimming-feet (Pl. II. Figs. 2, 3, 4, *IX*). These swimming-feet, which ultimately become the anterior pair of chelipeds in the adult, have about the same structure as the antecedent maxillipeds, but are somewhat shorter.

At the base of the appendages just mentioned are the rudiments of the following two pairs in the shape of small double sacs (Pl. II. Fig. 4, *X*, *XI*). The second pair are very small, and appear now for the first time.

There is still no trace of the abdominal limbs, except in some specimens about to moult, in which the last pair (swimmerets) are visible through the transparent integument within the caudal fin (Pl. II. Fig. 3, *XIX*). They have the shape of oval plates lying within the sides of the triangular telson.

Third Larval Stage (Pl. II. Figs. 5 – 9). — Larvæ in this stage of development were frequently taken free-swimming at the surface of the water, both at Newport and Wood's Hole, in July and early August. From their slight advance upon the preceding form, I have little doubt of their coming from it by a single moult, although I did not succeed in raising this stage in confinement.

In general form the larva still bears a close likeness to the stage last described. The telson, however, has lost its broad, triangular shape, and now, flanked by the free, bilobed swimmerets, renders this stage distinguishable at a cursory glance from either of the preceding ones.

In addition to the spines seen on the carapace in the second larval stage, there is now a minute one on the anterior border, below the supra-orbital spine. This seems to correspond to the antennal spine in the adult.

The first pair of antennæ are no longer simple, the rudiments of the inner flagellum having appeared as a small bud (Pl. II. Fig. 5, *I*, *r i*) from the inner side of the distal end of the second segment. It is tipped by a long seta. The segment which terminated the simple antennule of the previous stage now appears as the rudimentary external flagellum (Pl. II. Fig. 5, *I*, *r e*).

In the second pair of antennæ the inner branch (Pl. II. Fig. 5, *II*, *r i*), which becomes the chief part of the antenna in the adult, has

become divided by a transverse suture near its base, so that it now consists of two segments, a short proximal and a long, slender, distal one. The external branch of the second antennæ (Pl. II. Fig. 5, *II*, *r e*) has increased in size, but otherwise has suffered little modification.

The posterior border of the labrum, which bounds the mouth in front (Pl. II. Fig. 7), when viewed under a high magnifying power is seen to be serrate with minute teeth.

The mandibles and maxillæ (Pl. II. Figs. 5, 8, 9) have undergone little change.

A fifth pair of swimming-feet (Pl. II. Fig. 5, *X*) has developed from the anterior of the sac-like buds behind the last pair of swimming-feet of the preceding stage. This pair of swimming feet corresponds to the second or larger pair of chelipeds of the adult *Palæmonetes.* They are similar in make to the preceding pairs, but somewhat shorter. The antecedent pair of swimming-feet have gained in length, so that they now equal, if they do not slightly exceed, the pair in front of them. The segmentation of the inner branches of all the swimming-feet is more distinct than at first, dividing them into four segments, at least in the hindmost three pairs.

A new pair of sac-like appendages (Pl. II. Fig. 5, *XII*?) have developed behind the swimming-feet, so that we still have two pairs (*XI* and *XII*?), which will disclose swimming-feet after the next moult. The gills have begun to develop at the base of the swimming-feet.

The broad triangular fin which terminated the abdomen in the last stage has by exuviation freed the posterior pair of abdominal appendages (Pl. II. Fig. 5, *XIX*), of which we have seen the rudiments through the transparent integument in the previous stage. Both branches of these appendages are developed as two oval plates, of which the outer is two thirds the length of the telson, the inner about one third. The larger plate is fringed with fine setæ on its inner, and on the hinder portion of its outer, border. The telson itself, as before said, is much narrower than before, and is separated by a suture from the sixth abdominal segment. Its hind margin now bears but twelve long setæ, the external one on each side having disappeared.

On the lower side of the thorax, between the bases of the swimming-feet, is a good deal of green pigment beautifully arranged in dendritic figures. Other parts of the body also are rendered conspicuous by spots of red, green, and yellow.

Length, 3.5 mm.

Fourth Larval Stage (Pl. II. Figs. 10–15; Pl. III. Figs. 1–3). — At

the next moult the larva assumes the form represented on Plate II. Fig. 10. Considerable structural advance appears in the antennæ, in the acquisition of another pair of swimming-feet, and the rudiments of all the abdominal appendages.

The carapace now has two spines pointing forward in the median dorsal line. The inferior side of each of these is armed with minute, recurved teeth. The successive unfolding of the swimming-feet from before backwards has been accompanied by a lengthening of the carapace in a posterior direction, so that when the last pair has appeared the bases of the whole line of limbs are covered by the branchiostegite.

The rudimentary inner flagellum of the first pair of antennæ (Pl. II. Fig. 11, *r i*) has increased a little in size, but is still composed of one segment. The inner branch of the second antenna (Pl. II. Fig. 12, *r i*) has gained in length in relation to the outer branch, and is now divided into three segments, of which the first and second are short and thick, the third long and style-shaped.

The sixth pair of biramous natatory appendages (the third pair of Decapodal legs) are now present, and the first sign of the formation of chelæ on the two antecedent pairs appears in the slight production of the antero-internal angle of the penultimate segment of their inner branches. As will be seen further on, this angle becomes produced more and more until at last it forms a thumb opposable to the dactylus. The first two pairs of swimming-feet are now quite small compared with the following pairs, and begin to assume the proper function of maxillipeds. Behind the sixth pair of swimming-feet are the rudiments of the following two pairs of thoracic appendages (Pl. III. Fig. 1, *XII, XIII*; Figs. 2, 3). The seventh pair (Fig. 2) are double; the eighth pair, or hindmost thoracic appendages (Fig. 3), simple, sac-like structures. They are bent forward underneath the thorax, and concealed by the appendages in front of them.

The appendages of the abdominal segments from the first to the fifth inclusive are now for the first time seen (Pl. II. Fig. 10, *XIV–XVIII*). They are simple buds from the lower face of the abdomen, and in a side view they are almost concealed by the pleuræ. The appendages of the sixth segment of the abdomen (Pl. II. Fig. 15) have now acquired a shape nearly like those of the adult prawn. The inner plate (*r i*) is almost as long as the outer (*r e*), and both are clearly defined from one another and from the basal segment (protopodite). Both plates are provided with long and delicately fringed setæ arranged as represented in the figure.

The posterior border of the telson (Pl. II. Fig. 15, *t*) now but slightly exceeds the anterior end in width. It is deeply concave, and furnished with but eight long setæ. The spaces between the long setæ contain two very small setæ; those in the median interspace are longer than the rest.

It appears from my notes that on the 8th of August, 1878, a specimen in the stage described above as the third moulted in one of my aquaria, and then appeared in a shape differing in one respect from that which I have just described as the fourth larval stage. Besides the acquirement of the sixth pair of swimming-feet, the *seventh* pair were developed in this specimen as biramose, clearly segmented, setiferous appendages (Pl. II. Fig. 14), but very small in size compared with the sixth and preceding pairs. The last pair of thoracic limbs were simple, sac-like organs. This early development of the seventh pair of swimming-feet I regard as premature; in the normal course of development it is anticipated by the eighth pair, as will appear presently.*

Fifth Larval Stage (Pl. III. Figs. 4 – 13). — This stage was reared from the fourth stage in one of my jars. The most important structural advance upon the preceding stage consists in the full development of the hindmost pair of thoracic appendages. The flagellum of the second pair of antennæ has increased in length, and the long terminal segment shows a faint indication of division into four segments. There is a short spine (Fig. 4, *II*, *sp.*) on the outer side of the distal end of the posterior antennæ, which becomes larger in later stages of the development. This spine is more highly developed in the larvæ of *Paguridæ*, and represents the enormously developed spinous process of the second pair of antennæ so frequently found in the zoëæ of the *Brachyura*. From the exuviæ of one individual I obtained for the first time the complete structure of the mandible (Fig. 7, *III*). It is composed of two branches, as in the adult, but the anterior branch, instead of presenting a molar crown, as in the full-grown animal (Pl. IV. Fig. 19), ends in multidenticulate incisor edge. This branch is concealed beneath the fleshy labrum, and hence escaped detection in the earlier stages.

The chela of the fourth pair of swimming-feet is more perfectly formed than before, the penultimate segment being much enlarged, with its internal angle produced as far as the middle of the terminal segment

* I find among some larvæ which I preserved in alcohol one specimen with five pairs of natatory appendages (in this agreeing with the third stage above described), but in every other respect agreeing with the fourth stage. Behind the last pair of swimming-feet are the double, sac-like rudiments of the two following pairs. Length, 4 mm.

(Fig. 4, *IX*). The chela of the following pair of appendages is not so much developed as yet. The penultimate pair of thoracic legs (Fig. 4, *XII*) are still rudimentary, unsegmented, double sacs.

The last pair of thoracic legs, however, are fully developed as long, simple, 5- or 6-jointed appendages (Fig. 4, *XIII*). This pair alone of all the thoracic appendages are destitute of external branches from their very earliest appearance. They are generally borne curved forward under the sternum, in which position the distal segment (which bears a long, coarse terminal bristle) reaches forward to the maxillæ. The inner branches of the double thoracic legs are in the same way tucked under the breast when the animal swims.

The appendages of the first, second, third, fourth, and fifth abdominal somites have gained in size. The second, third, and fourth pairs (Fig. 11) present a little lobe on the inner side (*r i*), which is the beginning of the formation of the inner branch.

The telson (Fig. 13, *t*) is at this stage narrower behind than in front. Its hind margin is armed with eight setæ.

Length, 5.5 mm.

Sixth Larval Stage (Pl. III. Figs. 14 – 16 ; Pl. IV. Figs. 1–8). — The larva issues from the next moult provided for the first time with all the swimming-legs. The sacs which represented the penultimate pair previous to the moult have set free a pair of two-branched limbs similar to those in front, but with quite small external branches. This is the nearest approach to a true *Mysis*-stage which appears in the development. It differs from the Schizopod in the lack of the outer branch of the last thoracic feet.

Besides the unfolding of the penultimate pair of thoracic appendages, there is but little change from the phase immediately before the last moult. The inner branch of the second antennæ (Pl. III. Fig. 14, *r i*) is clearly divided into six or seven segments. The chelæ (Pl. III. Figs. 15, 16) are more perfectly formed. The two lobes of the abdominal appendages (Pl. III. Fig. 17) have become enlarged and marked off by constriction from the basal portion of the limb. The posterior border of the telson (Pl. III. Fig. 18, *t*) is cut into a shallow notch, and bears three pairs of long setæ. In the interval between the central pair are two much smaller setæ.

Length from tip of the rostrum to end of the telson, 6 mm.

I succeeded in rearing this stage through two successive moults. The resulting forms differed so little from the one just noticed (no new structures appearing), that I have included all three under the name of *sixth larval stage*.

After the first moult the larva had the form represented on Plate IV. Fig. 1. The general shape is very much like the adult, but all the feet except the last pair are provided with an outer swimming branch. The armature of the carapace is now as follows: two large spines in the median dorsal line, the anterior of which lies over the base of the eye-stalks; one on each side near the anterior margin, on a level with the eye-stalks; all of these are directed forward and furnished with minute recurved teeth on their lower sides; in addition to these there is a small antennal spine on each side of the carapace on the anterior margin on a level with the base of the second pair of antennæ, and a very minute spine at the antero-inferior angle of the carapace just below the antennal spine; this is probably the branchiostegal spine in the adult. The rostrum is furnished with hairs on its upper edge in front of the anterior dorsal spine. The peduncle of the first pair of antennæ is now divided into three segments; both the inner and outer branches have increased in length. The flagellum of the second pair of antennæ (Fig. 2, *r i*) exceeds the scale in length, and its distal half is divided up into six or seven segments. The first pair of maxillipeds (Fig. 1, *VI*) are very small compared with the Decapodal legs; the second and third pairs increase in length successively. The chelipeds (*IX*, *X*) are terminated by a perfect claw, in which the process of the penultimate segment is equal in length to the dactylus; both dactylus and the opponent process are furnished with a few plumose setæ. The exopod of the penultimate thoracic limbs has now attained a size equal to that of the limbs in front. The appendages of the abdomen (*XIV*–*XVIII*) are much larger than before the last moult; a small projection from the inner border of the internal rami of the second to the fifth pairs (Fig. 5, *s*) is the beginning of the slender stylet in the adult (Fig. 26, *s*); both branches are now furnished with long plumose hairs; the inner branch of the first pair (Fig. 4, *r i*) is rudimentary.

One individual of the form just noticed died during the process of exuviation in one of my aquaria. It sufficed to show that the larva after the moult differed in no important regard from the antecedent form. The tooth on the outside margin of the outer blade of the swimmerets, which is so conspicuous in the adult (Fig. 29), is beginning to appear (Fig. 8). The telson is still armed with three pairs of long bristles (Fig. 8); within the inner pair are two of very minute size.

Length, 8 mm.

I failed to rear any of the larvæ in confinement beyond this stage. The next form in the series which I have met with is the one repre-

sented by Fig. 15 of Plate IV. This was frequently taken in the hand-net free-swimming at the surface of the sea. Although but eight millimetres long, the larva has acquired the form and almost every character of the adult prawn.

Among the drawings of Crustacean larvæ made by Mr. Agassiz at Newport, which he has generously placed at my disposal, are some details of the structure of a larval stage of *Palæmonetes vulgaris* which happily fills in some measure the gap between the sixth larval stage and the adult form. This phase in the development I will designate as the

Seventh Larval Stage (Pl. IV. Figs. 9 – 14). — There is no sketch of the general form of this stage among Mr. Agassiz's drawings. The rostrum (Pl. IV. Fig. 9) is long and scymitar-shaped, with six teeth above and two below. Between the teeth of the dorsal side are hairs, as in the adult. The anterior third of the rostrum is destitute of teeth. The carapace is armed, moreover, with an antennal and a minute branchiostegal spine on each side. The supra-orbital spine is reduced to a mere rudiment.

The natatory branch of the maxillipeds and legs (Pl. IV. Figs. 10, 11, 13, *r e*) is reduced to a short style composed of one segment. In this we see an interesting transition state between the Schizopod and the Decapod leg. The inner branches of the first and second pair of maxillipeds have also diminished, and now consist of one and two segments respectively (Pl. IV. Figs. 10, 11). The segments of the internal branches of the chelipeds and ambulatory appendages are clearly seven in number. The last pair of thoracic legs (Pl. IV. Fig. 14) is of course without the external styliform appendage.

The antennæ, swimmerets, and telson are not represented in Mr. Agassiz's figures, nor is the natural size indicated.

Specimens in the sixth larval stage may measure eight millimetres from the tip of the rostrum to the tip of the telson. This is as long as specimens which have attained the adult form, such as is represented by Figure 15 of Plate IV. Hence I infer that but few stages intervene. It is highly probable, however, that the larva suffers one or two moults between the seventh stage and the attainment of the shape of the adult prawn.

Early Stage of the Adult Form (Pl. IV. Fig. 15). — Although measuring only eight millimetres from the tip of the rostrum to the end of the telson, the prawn has now the true Decapod structure; although still a free-swimming surface-dweller. Every trace of the external swimming-branches of the five pairs of legs has vanished, and the structure is in

almost every detail like that of the adult prawn, parts of which are represented on Plate IV. Figs. 16 – 31. The integument, however, is much thinner and more transparent, the legs are longer, and the external plate of the swimmerets is not divided by a transverse suture. The rostrum (Pl. IV. Fig. 32) is nearly as long as the portion of the carapace behind it. Viewed in profile, it increases in depth from the root to beyond the middle, thence tapers with a gentle upward curve to a fine point at the tip. It is armed above with seven, below with three, teeth. The second tooth, counting from the base, lies over the proximal end of the eye-stalks. They are all directed forward, and in the intervals between them are two or three hairs.

As the prawn develops, new teeth are added between the older ones and the tip of the rostrum. In a specimen which measures 9 mm. in length, the dental formula is $\frac{8}{3}$ (Pl. IV. Fig. 33). In the mature prawn the number of teeth on the rostrum is commonly nine above and four below (Pl. IV. Fig. 30), but is subject to great variation. Thus, I find on looking over a large series of specimens measuring from 28 mm. to 42 mm. in length, the following formulæ for the rostral teeth :

$$\frac{11}{4},\ \frac{10}{4},\ \frac{10}{3},\ \frac{9}{4},\ \frac{9}{3},\ \frac{9}{2},\ \frac{8}{5},\ \frac{8}{3},\ \frac{8}{2},\ \frac{7}{2},\ \frac{6}{3},\ \frac{6}{2}.$$

Hence will appear the folly of those zoölogists who have taken the form of the rostrum as a means for distinguishing species in the group of *Caridea.* The carapace is provided, moreover, with an antennal and a branchiostegal spine on the fore margin of each side. There is now no trace left of the large supra-orbital spine which was so conspicuous in most of the larval stages. The pterygostomian angle is rounded off as in the full-grown individuals. The pleuræ of the fifth abdominal segment extend backward over the following somite, but are not drawn out into a long spine as in the larval stages.

The telson has the same form and armature as in full-grown specimens. It tapers posteriorly to a very narrow hind margin which is produced in the middle in the form of a stout tooth. From the lower face of this median tooth issue a pair of long, plumose setæ. On each side of the median tooth is a long spine, which is articulated with the telson, and outside of these is a short spine, similarly articulated with the external angle of the posterior border of the telson. The dorsal surface of the telson has four small spines arranged as in the mature prawn.

The third flagellum of the first pair of antennæ is now present as a short, two-jointed appendage tipped by fine hairs (Pl. IV. Fig. 15, *r e′*). It does not issue from the peduncle of the antennule, but from the inner

side of the third segment of the primary (external) flagellum. In full-sized individuals the free portion of the tertiary flagellum may have as many as thirteen or fourteen segments, and the distance between its base and the base of the primary flagellum may contain as many as eight segments.

The second pair of antennæ are about as long as the body. The mandibles (Fig. 18) are two-branched. One of the branches is terminated by a molar surface (Fig. 19), the other by *three* incisor teeth in the right mandible (Fig. 18), *four* in the left (Fig. 20).

The first pair of maxillæ (Fig. 21) consist of two lobes (*a*, *b*), which are fringed with setæ on their inner borders, and a palpus (*r i*) bilobed at its free end.

The second pair of maxillæ (Fig. 22) are composed of a bifid inner plate (protognath, *a*) fringed on its internal border with setæ, a middle piece (endognath, *r i*) composed of one segment, and a large ear-shaped scaphognathite (exognath, *r e*), whose margin is beset with long and delicate hairs.

The first pair of maxillipeds (Fig. 23) have a very complicated structure. The inner, prehensile portion consists of two thin, foliaceous lobes (*a*, *b*), of which the distal (*b′*) is the larger. The edges of both are provided with setæ. The other parts of the organ are probably tactile and respiratory in their function, and consist of a tongue-shaped middle piece (*r i*); an external, large, oval plate which gives off a long palpiform appendage (*r e*); and two small oval plates (*e p*, *e p′*) at the base of the larger external plate. The inner margin of the latter, and the distal third of its appendage, are fringed with fine setæ. The two smaller external plates (*e p*, *e p′*) are of a soft consistency, and very probably serve in a measure to aërate the blood.

The penultimate segment of the endognath of the second pair of maxillipeds (Fig. 24) is produced on the inner side into a large lobe, to the distal margin of which the terminal segment is articulated. The two segments together thus form a broad oval blade, which is reflected upon the inner side of the antecedent segments, and lined with setæ on its oral border. The exognath (*r e*) is long and slender. At the base of the limb, on the external side, are a small roundish epignath (*e p*) and a small but well-formed gill (*b r*).

The third pair of maxillipeds (Fig. 16) are composed of the same parts as the second maxillipeds, but the inner branch (*r i*) is pediform and twice the length of the external branch (*r e*).

The structure of the following thoracic appendages is so well known

that a detailed description of them would be superfluous. In specimens 8 mm. or 9 mm. long the transverse suture of the exopod of the swimmerets (Fig. 15, *XIX*, *r e*) has not yet appeared. As in full-grown individuals, the inner side of the tip of the styliform appendage of the preceding abdominal members (Fig. 26, *s*) is furnished with microscopic curled hairs (Fig. 27), whose function I cannot imagine. They occur in both sexes. The internal branch of the second pair of abdominal members in mature male specimens presents a second slender inner appendage (Fig. 28, *s'*) fringed with hairs on its outer margin. The small endopod of the first pair of abdominal appendages, moreover, is differently shaped in the two sexes. In the male, the distal third widens and trends slightly inward; on the inner margin, near the base, are some long setæ; the distal portion bears short, plumous setæ. In the female, the endopod narrows gradually from its root to the tip, and is fringed at the end and along the internal border by long feather-like hairs.

In the above-described series of larval forms I have never obtained the third stage directly from the second, but with this exception I have actually reared in confinement each successive stage from its predecessor, from the first to the sixth inclusive.

The only larva known to me on this coast liable to be confounded with *Palæmonetes* is that of *Virbius zostericola* Smith. In specimens 6.5 mm. long, still in the Schizopod condition, the carpus of the second pair of feet is already tri-articulate, and the setæ of the telson, form of the antennal scale, and other characters serve to distinguish it from the young *Palæmonetes.*

It appears, from what precedes, that *Palæmonetes* issues from the egg in the zoëa-form, i. e. provided with a pair of compound eyes, two pairs of antennæ, two pairs of maxillæ, and three pairs of swimming-feet, the future maxillipeds. Behind the third pair of swimming-feet are the rudiments of the following two pairs of appendages in the shape of double sac-like structures. No gills exist, the aëration of the blood being accomplished through the general integument, and especially under the sides of the carapace, by means of a current of water maintained, as in the gill-bearing adult, by the constant motion of the broad external plate of the second maxillæ. The abdomen is wholly devoid of appendages, and the telson is not clearly marked off from the sixth abdominal segment.

As development proceeds, the rest of the thoracic legs are unfolded in succession from before backward. The only break in the regular order of succession is caused by the unfolding of the last pair earlier than the

penultimate. All the thoracic appendages, excepting the last pair, are furnished with external natatory branches. By subsequent moults the natatory branches are reduced in size, and finally disappear altogether. During the evolution of the thoracic limbs, the abdominal appendages make their appearance, first the posterior pair (which develop within the caudal plate or telson), then the anterior pairs.

The different forms which the individual assumes during its development are in this case the result of gradual growth, each successive moult developing a form which shows but a slight advance upon the one immediately preceding it. It is, nevertheless, a true metamorphosis, involving the acquirement of new structures, the atrophy of others, and change of function of still others; the structural difference between the young larva and the adult prawn being much greater than in insects with a so-called incomplete metamorphosis, like the *Orthoptera*.

I am inclined to think there is error in many of the observations recorded of consecutive stages in the development of the *Macroura* captured with the hand-net or tow-net. In most of these cases the great difference in form between the specimens warrants the assumption that intervening stages are missing. Consecutive stages which I have actually reared in confinement often do not differ appreciably from one another in size, so that one cannot be sure from the relative size alone of his larvæ that links are not wanting in his chain of forms.

Excepting the statement of Agassiz that *Palæmonetes vulgaris* hatches from the egg as a *Cuma*,* the only notice of the developmental history of this species, with which I am acquainted, is the short description of the first larval stage, by S. I. Smith, already cited.†

But few observations have been made upon the development of the European species of *Palæmon*, which is somewhat strange when one considers how common some of them are.

The first naturalist who published anything concerning the development of the genus was Rathke, who made some observations in 1833 upon the growth of the embryo within the egg of *Palæmon adspersus* Rathke (= *P. rectirostris* Zaddach, according to Heller),‡ and *Palæmon squilla*.§ These observations are so full of error that they have only an historical interest. Prejudiced by his studies upon the devel-

* Amer. Jour. Sci. and Arts, 2d Series, Vol. XIII. p. 426. 1852.

† *Supra*, p. 304.

‡ Die Crustaceen des südlichen Europa, p. 270. 1863.

§ Ueber die Entwickelung der Decapoden. Müller's Archiv, 1836, pp. 187-192. Zur Morphologie, Reisebemerkungen aus Taurien, pp. 81-93, 179-184, Pl. IV. Figs. 1-10. 1837.

opment of *Astacus*, Rathke came to the conclusion that the prawn too acquires, while still within the egg, all the external parts (excepting the sexual organs) which are found in the adult, and that it is subject to no greater structural changes after leaving the egg than a bird is! After further researches upon the development of Decapods, Rathke acknowledged his error, and his handsome tribute to J. V. Thompson, in this connection, is a notable example of candor.*

The changes which the young suffers after leaving the egg were first observed by J. V. Thompson. In the summer of 1828 he obtained the first stage of the larva by hatching the eggs of *Palæmon serratus*, and in a paper published in 1836 † gave a rough figure of this, together with two older larval prawns which he supposes to belong to the same species, although they were captured free-swimming.

How much allowance must be made for inaccuracy in Thompson's figures it is hard to say. The first stage is represented with but two pairs of cleft members; in the second stage the larva has acquired an additional pair of swimming-feet, the sixth pair of abdominal appendages are present, and form with the telson a terminal fin about like that in our third larval stage. There is yet no dorsal spine on the carapace, and the first pair of antennæ are still simple.

The third stage apparently represents a phase somewhat more advanced than our sixth stage. The carapace is now armed with three spines on the median dorsal line, and a supra-orbital spine on each side. All of the appendages are now present, the chelæ are well formed, and all of the thoracic members, not excepting the posterior pair, are furnished with a natatory branch. The flagellum of the second pair of antennæ is in the condition of the adult, being divided into an indefinite number of annuli. In other respects the young prawn agrees pretty well with the sixth stage of *Palæmonetes*.

The most complete account of the larval stages of *Palæmon* up to the present time is that of Captain DuCane, published in 1839, in the second

* Zur Entwickelungsgeschichte der Dekapoden. Arch. f. Naturgesch., 1840, I. p. 248.

Beiträge zur vergleichenden Anatomie und Physiologie, Reisebemerkungen aus Skandinavien, p. 46. Neueste Schriften der Naturforsch. Gesell. in Danzig, Vol. III. 1842.

† Memoir on the Metamorphosis in the Macrouræ or Long-tailed Crustacea, exemplified in the Prawn (Palæmon serratus). Edinburgh New Philosoph. Jour., Vol. XXI. pp. 221-223, Pl. I. 1836. A short notice of this paper appears in the "Abstracts of the Papers printed in the Philosophical Trans. of the Royal Soc.," Vol. III. p. 371. 1836.

volume of the Annals of Natural History.* In this communication the author gives a brief description and rude figures of four larval stages of the ditch prawn, *Palæmon variabilis* [*Palæmonetes varians* Heller ?]. The earliest form represented is that which the larva assumes immediately after exclusion from the egg. The first pair of antennæ are portrayed with *two* terminal, one-segmented branches, a condition not seen in any other figures of the first larval stage of *Palæmon*. As in Thompson's figure of the same stage, only two pairs of swimming-feet are represented. Behind them are the rudiments of the true legs in the shape of three pairs of small, simple, two-jointed processes. The number of abdominal segments is plainly exaggerated.

In the second stage, "ascertained by observing the moult of the former," the carapace is armed with a dorsal spine at the base of the rostrum, and all the thoracic legs are present! The posterior pair are destitute of the natatory branches; the chelæ are developed. It is noteworthy that the author expressly states that the abdominal appendages have begun to appear, excepting the last pair. If this be correct, it is certainly an exceptional order of development among the *Macroura*. Commonly in this group the posterior pair appear before the other abdominal appendages.

In the third stage, "also ascertained by witnessing the moult," the carapace has two dorsal and supra-orbital spines, and the posterior pair of abdominal limbs have appeared.

The fourth stage was not obtained directly from the third by observing the moult. The larva now has three dorsal spines, and, excepting the want of external branches to the last pair of thoracic legs, agrees well with Thompson's third stage. The next moult brought it to the condition of the adult prawn.

It is obvious from the above account that the number of forms passed through by the larva before reaching the adult shape is much smaller than in the case of *Palæmonetes vulgaris*, unless there is error in the observations of DuCane.

The next observation bearing upon the development of *Palæmon* is found in Fritz Müller's "Für Darwin." † It consists of a brief description, accompanied by a wood-cut, of what seems to be the first larval stage.

The researches of Bobretzky upon the development of *Palæmon*, published in the Russian language, at Kief, in 1873,‡ have already been

* Letter from Captain DuCane, R. N., . . . on the subject of the Metamorphosis of *Crustacea*, Ann. Nat. Hist., Vol. II. pp. 178 – 181, Pl. VI, VII. 1839.

† Für Darwin. 1864. English Trans. by W. S. Dallas, p. 55, Fig. 27. 1869.

‡ Zapiski Kiefs. Obshtshest. Yestestvoispitatalyei, Vol. III. pp. 186–252, Pl. IV–VI. 1873. Hofmann und Schwalbe's "Jahresberichte," Vol. II. pp. 317, 318. 1875.

referred to. They relate almost exclusively to the intra-oval development, and for this part of the history are the completest yet made, the microtome having been used for getting sections of the egg in the different stages of its growth.

In 1874 Anton Stuxberg published an incomplete description of the embryo before hatching, and of the first larval stage of *Palæmon squilla.**

In an abstract of a paper on the development of *Crustacea*, by Spence Bate, in the Proceedings of the Royal Society of London, 1876,† (the full paper has never been published to my knowledge), the author makes the surprising statement, that in the embryo of *Palæmon*, etc., the anterior of the three earliest formed pairs of lobes (nauplius-appendages) develop directly into the eyes, while the posterior two pairs are cast off with an early moult and replaced by the permanent antennæ !

CAMBRIDGE, June 1, 1879.

* Karcinologiska iakttagelser. Öfversigt af Kongl. Vetenskaps-Akad. Forhandl., 1873, No. 9, pp. 16 – 19. 1874.

† "On the Development of the Crustacean Embryo, and the Variations of Form exhibited in the Larvæ of 38 Genera of Podophthalmia." Proc. Royal Soc. London, Vol. XXIV. pp. 375 – 379. 1876.

I believe I have not misrepresented Spence Bate here, but will quote in full: — "The author has taken this opportunity of making a close examination into the earlier stages in the development of the embryo, and comparing the progress within the ovum of some of the larvæ that arrive at or near maturity before being hatched, with those of the larval forms that are hatched in a more immature condition ; and he states that, as soon as the protoplasm assumes anything like a definite plan, distinct lobes, corresponding in position with those of the several appendages in the *Nauplius*, together with an embryonic or ocular spot, are present ; that in the *Nauplius* forms they exist as deciduous appendages only, and are soon cast aside and replaced by others more adapted to the wants of the adult existence.

"In the embryos of other Crustacea the anterior pair of lobes enlarge in size with little alteration of form, while the posterior two pairs are developed into appendages that have but a deciduous value, since they never fulfil the office of permanent organs, and are generally cast off with an early moult.

"This is observable within the ovum in *Palæmon*, *Crangon*, etc., and also in the marsupial embryo of *Mysis* after it has quitted the ovum.

"The relation of these parts to the permanent organs the author has closely traced, and believes that he has demonstrated that the three pairs of mobile appendages in the cirripedal or *Nauplius* form of larva homologize with the eyes and two pairs of antennæ, and not with the antennæ and mandibles, as stated by Fritz Müller, Anton Dohrn, and others."

EXPLANATION OF THE PLATES.

The appendages, from the first to the last pair, are indicated throughout by consecutive Roman numerals. They correspond with the appendages of the adult as follows: —

I, first antenna.	*XI*, third pair of legs.
II, second antenna.	*XII*, fourth " "
III, mandible.	*XIII*, fifth " "
IV, first maxilla.	*XIV*, first pair of abdominal appendages.
V, second maxilla.	*XV*, second " " "
VI, first maxilliped.	*XVI*, third " " "
VII, second maxilliped.	*XVII*, fourth " " "
VIII, third maxilliped.	*XVIII*, fifth " " "
IX, first pair of legs (cheliferous).	*XIX*, sixth " " "
X, second " "	

The Arabic numerals denote the somites of the abdomen.

a b, abdomen.	*n g*, nerve-ganglion.
a r, artery.	*o c*, compound eye.
c d, cephalic disk.	*o c l*, ocellus.
c p, carapace.	*r e*, external branch of appendages.
h t, heart.	*r i*, internal " "
i n, intestine.	*r s*, rostrum.
l b, labrum.	*t*, telson.
m, mouth.	*v t*, yelk.

Plate I.

Fig. 1. Egg with four segments produced by an equatorial and a meridional cleavage. Each segment contains a nucleolated nucleus (*n*), around which delicate lines of protoplasm are disposed like rays.

Fig. 2. Egg with sixteen cleavage spheres.

Fig. 3. The surface of the yelk is now divided into small polygonal blastomeres. *g*, orifice of gastrula-cavity.

Fig. 4. Profile view of the embryo, four days after the gastrula-stage. The appendages have appeared from the first to the sixth pair. Excepting the first pair, they are bilobed or double.

Fig. 5. Embryo three days later, from the ventral side. The rudiments of the appendages are now seen from the first to the eighth pair (third pair of maxillipeds).

Fig. 6. Egg with the enclosed embryo further advanced, viewed from the side.

Fig. 7. The same, from above.

Fig. 8. Older embryo, from the ventral side.

Fig. 9. Still older embryo, from the side.

Fig. 10. Egg as it appears a few hours before hatching. *p*, the gluey secretion which fixes the egg to the abdominal appendages of the mother.

Fig. 11. Embryo extracted from the egg just before hatching. The rostrum (*r s*) lies bent under the head. The appendages of the right side are spread out in order that their structure may be seen.

Fig. 12. Second maxilla of the same.

Fig. 13. Appendages of the ninth and tenth pairs of the same (representing the two pairs of chelipeds in the adult).

Fig. 14. First larval stage, viewed from below. *a n*, anus.

Fig. 15. The same ; antenna of the first pair.

Fig. 16. The same ; antenna of the second pair. The inner branch (*r i*) develops into the flagellum ; the outer branch (*r e*) into the scale.

Fig. 17. The same ; parts about the mouth.

Fig. 18. The same ; two adjacent long setæ of the telson, with four very minute setæ in the interspace.

Plate II.

Fig. 1. First larval stage, viewed from the side.

Fig. 2. Second larval stage, viewed from the side.

Fig. 3. The same, viewed from above.

Fig. 4. The same ; oral and thoracic appendages.

Fig. 5. Third larval stage, from below.

Fig. 6. The same ; anterior part of the carapace, viewed from the side. *x*, dorsal spine. *y*, supra-orbital spine. *z*, antennal spine.

Fig. 7. The same ; posterior border of the labrum.

Fig. 8. The same ; first maxilla. *a*, inner lobe. *b*, outer lobe. *r i*, palpus.

Fig. 9. The same ; second maxilla. Only a small part of the scaphognathite (*r e*) is represented.

Fig. 10. Fourth larval stage, side view.

Fig. 11. The same ; first antenna. *r i* and *r e*, rudimentary flagella.

Fig. 12. The same ; second antenna.

Fig. 13. The same. *l b*, labrum. *m*, mouth. *III*, mandible. *m s*, metastoma. *IV*, first maxilla. *a*, *b*, *r i*, as in Fig. 8.

Fig. 14. The same; abnormally developed appendage of the penultimate thoracic pair.

Fig. 15. The same; telson and swimmeret.

Plate III.

Fig. 1. Fourth larval stage ; cephalo-thorax, from below.
Fig. 2. The same ; penultimate thoracic appendage.
Fig. 3. The same ; last thoracic appendage.
Fig. 4. Fifth larval stage ; cephalo-thorax viewed from below. *s p*, spinous process of second pair of antennæ.
Fig. 5. The same ; anterior part of the carapace.
Fig. 6. The same ; fifth abdominal somite, viewed from the side.
Fig. 7. The same ; labrum (*l b*) and mandibles (*III*).
Fig. 8. The same ; second maxilla.
Fig. 9. The same ; natatory branch of the tenth pair of appendages.
Fig. 10. The same ; abdominal appendage of the first pair.
Fig. 11. The same ; abdominal appendage of the second pair (those of the third and fourth pairs have the same form).
Fig. 12. The same ; abdominal appendage of the fifth pair.
Fig. 13. The same ; telson and swimmerets.
Fig. 14. Sixth larval stage, one moult after the fifth larval stage ; antenna of the second pair ; *s p*, spinous process.
Fig. 15. The same ; first cheliped.
Fig. 16. The same ; second cheliped.
Fig. 17. The same ; one of the abdominal appendages.
Fig. 18. The same ; telson and swimmerets.

Plate IV.

[NOTE. Figs. 9 – 14 are from drawings by Mr. A. Agassiz.]

Fig. 1. Sixth larval stage, two moults after the fifth larval stage, lateral view.
Fig. 2. The same ; second antenna ; *s p*, spinous process.
Fig. 3. The same ; cheliped with its external, natatory branch (*r e*).
Fig. 4. The same ; first abdominal appendage.
Fig. 5. The same ; second abdominal appendage.
Fig. 6. The same ; posterior margin of the telson.
Fig. 7. Sixth larval stage, three moults after the fifth larval stage ; anterior end of first antenna.
Fig. 8. The same ; telson and swimmeret.
Fig. 9. Seventh larval stage ; rostrum and eye.
Fig. 10. The same ; second maxilliped.
Fig. 11. The same ; third maxilliped.
Fig. 12. The same ; chela.
Fig. 13. The same ; rudimentary external branch (*r e*) of thoracic legs.
Fig. 14. The same ; posterior thoracic leg.
Fig. 15. Young prawn, 8 mm. long, which has acquired most of the characters of the adult.
Fig. 16. Adult ; third maxilliped.
Fig. 17. The same ; scale of second antenna.

Fig. 18. The same; right mandible.

Fig. 19. The same; molar crown of mandible.

Fig. 20. The same; end of incisor branch of left mandible.

Fig. 21. The same; first maxilla. *a*, inner lobe. *b*, outer lobe. *r i*, palpus. *e p*, epignath.

Fig. 22. The same; second maxilla. *a*, *b*, lobes of protognath. *r i*, *ramus internus*. *r e*, *ramus externus*, or scaphognathite.

Fig. 23. The same; first maxilliped. Letters as before.

Fig. 24. The same; second maxilliped. *b r*, gill.

Fig. 25. The same; first abdominal appendage.

Fig. 26. The same; fourth abdominal appendage. *s*, appendage on inner side of the internal branch.

Fig. 27. The same; tip of the styliform appendage (*s* of the preceding figure) of abdominal limbs, highly magnified to show the curled hairs.

Fig. 28. The same; inner branch of second abdominal appendages in the male, bearing *two* slender appendages, *s* and *s'*.

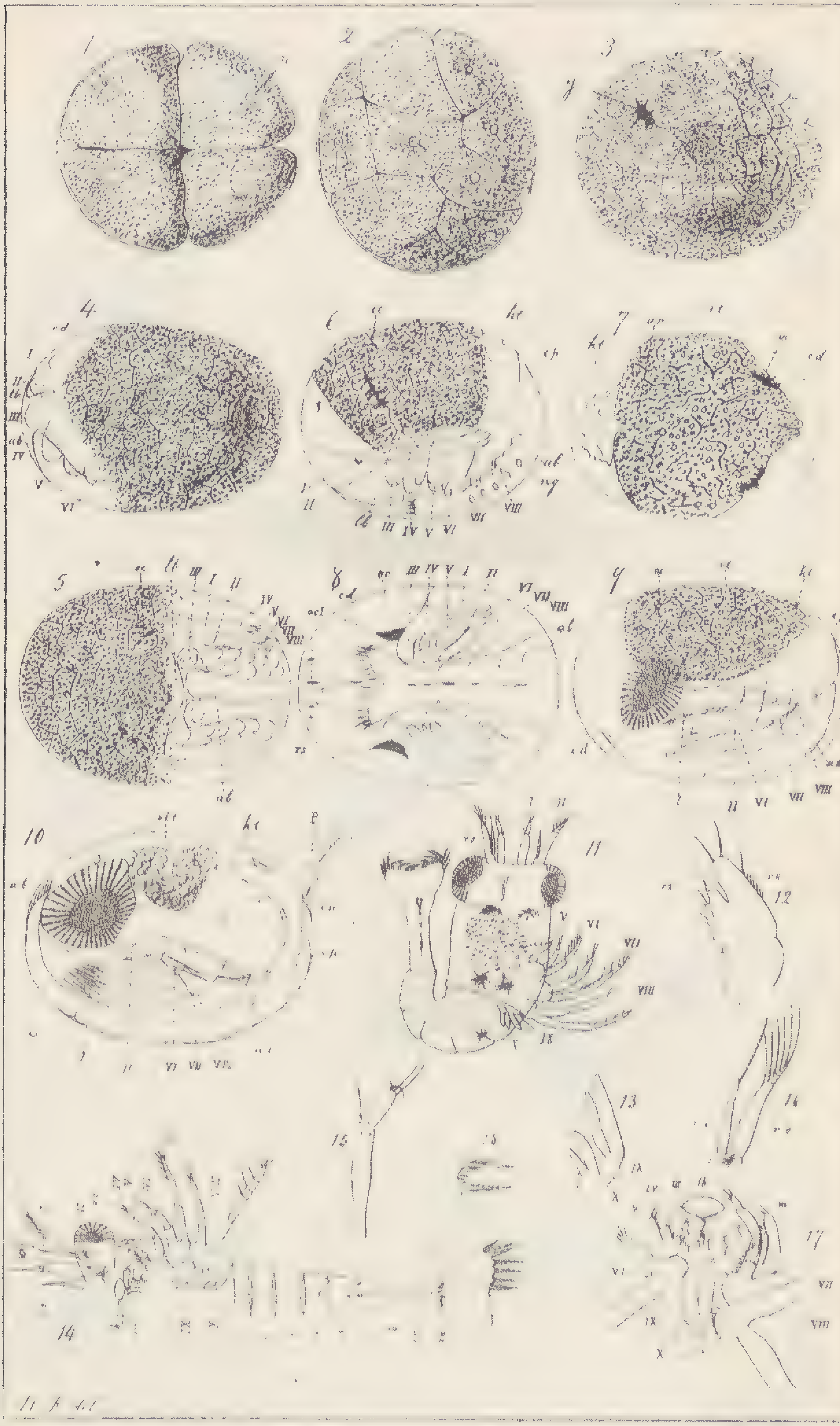
Fig. 29. The same; telson and swimmerets.

Fig. 30. The same; carapace.

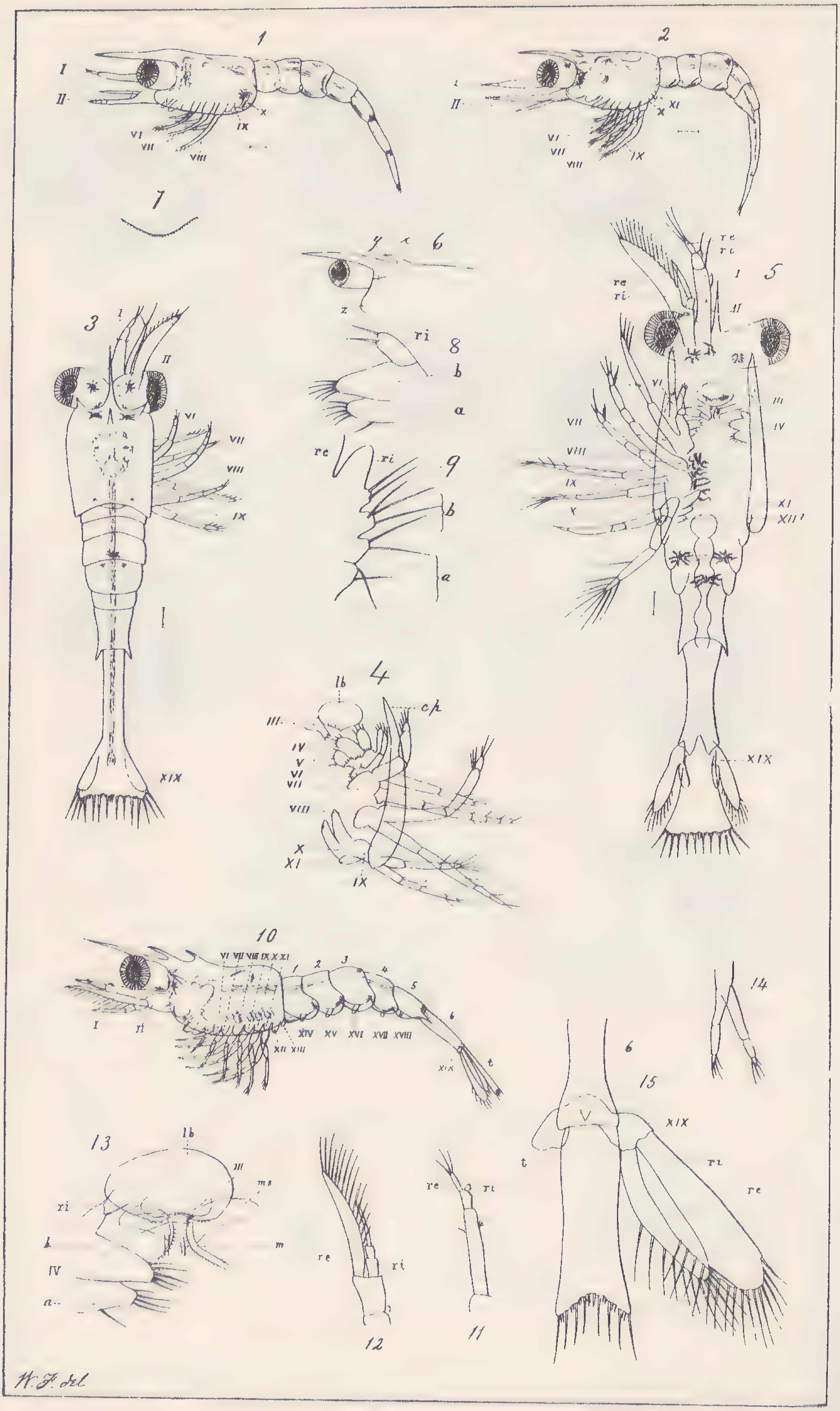
Fig. 31. Rostrum of another adult specimen.

Fig. 32. Rostrum of the specimen represented by Fig. 15.

Fig. 33. Rostrum of an individual 9 mm. long.



W. H. FISH. PHOTO-LITH. BOSTON.



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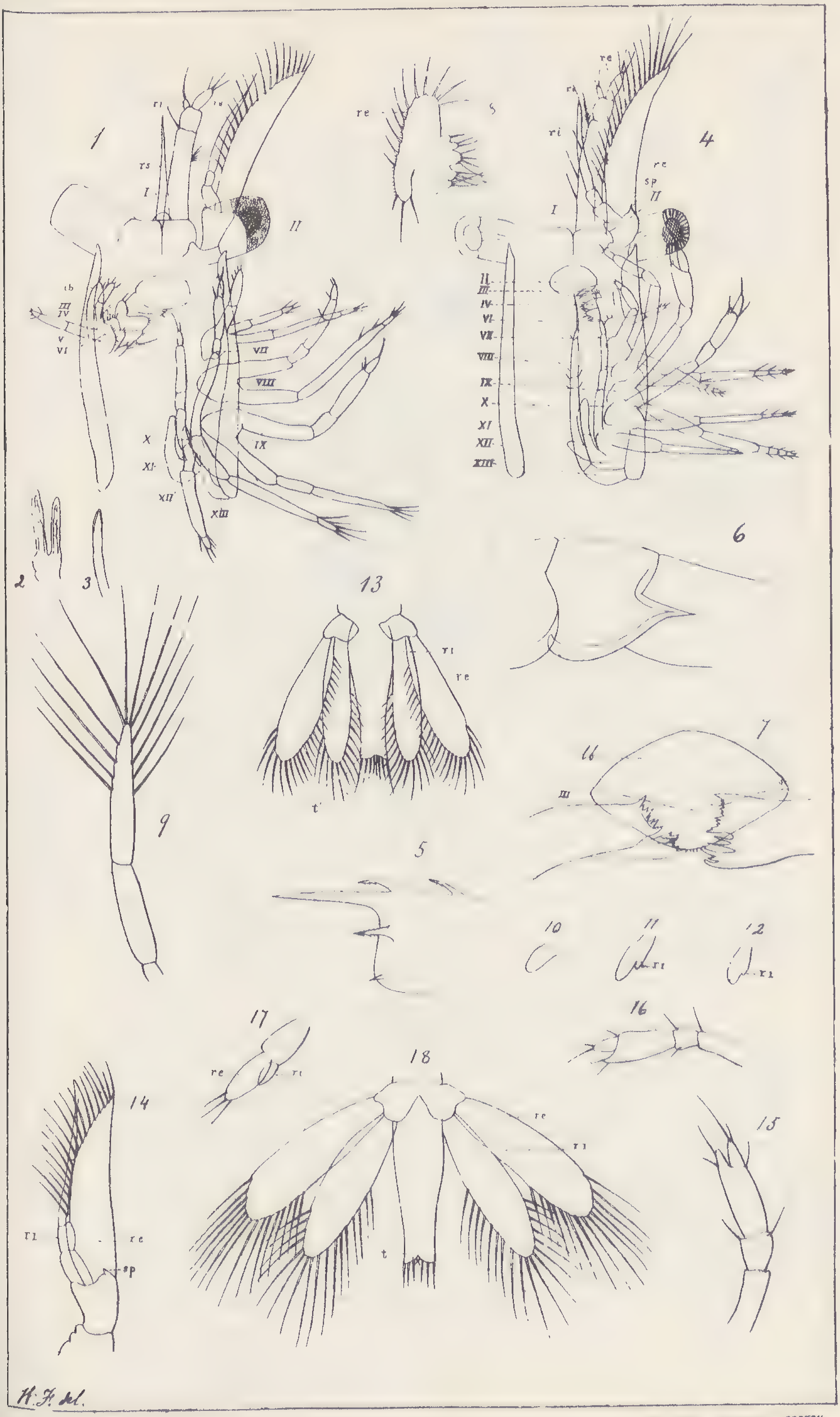

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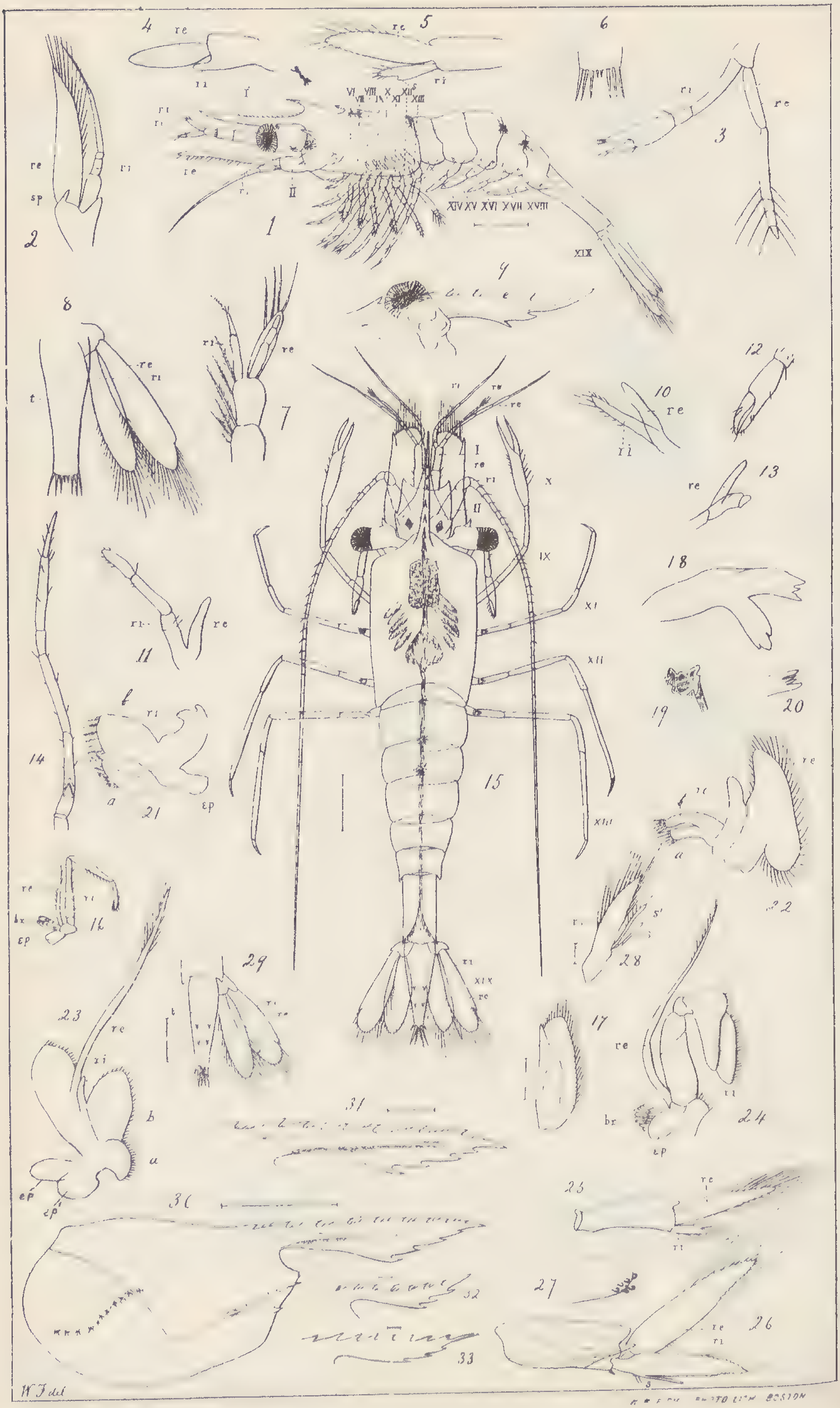
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No. 16. — *On the Jaw and Lingual Dentition of certain Terrestrial Mollusks.* *By* W. G. Binney.

(With two Plates.)

CHLAMYDEPHORUS.*

Animal (Pl. II. Fig. A) limaciform ; mantle covering the whole body, with an orifice on the centre of the back near the tail, enclosing at the same part a subhexagonal, solid, internal shelly plate : no caudal mucus pore ; distinct locomotive disk to foot ? external excretory, respiratory, and generative orifices ? tentacles and eye-peduncles two each : no jaw : teeth of lingual membrane (Pl. II. Fig. B) as in *Glandina*, arranged in chevron, aculeate.

This generic name is suggested for a peculiar slug collected by Mr. J. S. Gibbons in Natal Colony, Africa, and submitted by him to me. Its mantle covering the whole body can be compared only to that of Tebennophorus (*Megimathium, Incilaria, Philomycus*), Pallifera, Athoracophorus (*Janella, Aneitea, Triboniophorus, Aneitum*), Veronicella, and Vaginulus as restricted by Stoliczka (Journ. Asiatic Soc. Bengal, N. S. xlii. pt. 2, pp. 33–37) to the agnathous species resembling Veronicella. This last genus, Vaginulus, can alone be compared with the slug before me in wanting a jaw and having Glandina-like teeth on its lingual membrane, and at the same time not having any external shell. It differs, however, from the Natal slug in wanting the peculiar dorsal orifice, and the internal shelly plate. I am forced, therefore, to suggest a new name for this slug. The dried condition of the animal prevents me learning the position of the external orifice of generation ; I suspect that of respiratory and excretory organs to be through the hole on the centre of the animal's back.

The single specimen received is deposited in the collection of the Philadelphia Academy of Natural Sciences, together with the internal shelly plate and the mounted lingual membrane.

Chlamydephorus Gibbonsi.

Animal (Pl. II. Fig. A) elongate, rather slender, cylindrical, rather more than 3 inches long when fully extended, tapering towards head, broadest about ½ inch from tail, towards which it slopes ; tail rather blunt ; dorsum rounded, head small ; color a dark, dull orange, thickly mottled, and marbled with dark olive brown, the margin of the foot and mesial line of dorsum being the only parts where the ground color is well seen. A slight eminence on the broadest part of the body (near posterior end) is perforated by a round orifice, a line or rather more in diameter ; from this small orifice furrows radiate, passing to tail, to the margin of foot and forwards ; dorsum finely sulcato-striate from head to orifice, the striæ being granulose. A row of small regular tubercles runs along

* χλαμύς, φέρω.

mesial line from head to prominence; eye-peduncles very short, cylindrical, retractile, and of a dark neutral color ; tentacles similar, but shorter and lighter in hue ; below these last are a small subpellucid pair of false tentacles, a prolongation of the sole of the foot; below, the foot is dull opaque white with a tallowy yellow tint and with an indistinct bluish streak along middle.

One specimen under a stone in a wood, Ungeni Valley, Natal Colony.

When the mollusk wishes to rest it withdraws its head completely, brings together the two margins of the foot, and then doubles under the tail end.

The above is Mr. Gibbons's description. In my generic description it will be seen that there is no jaw. The lingual membrane is long and broad, consisting of about 52 chevron-shaped rows of 27–1–27 teeth, all as in *Glandina*, the central one differing only in being smaller than the adjacent marginals, and symmetrical, with a long, slender cutting point : there are no laterals, all the side teeth being purely aculeate marginals and first rapidly increasing and then gradually decreasing in size as they pass off laterally, as is usual in *Glandina* (Pl. II. Fig. B). Buccal mass very large indeed.

The internal shelly plate is quite thick ; it was in several pieces when found by me, but I doubt not its being in a single subhexagonal plate when perfect. It is 3 mill. long.

I regret that the dried condition of the single specimen received prevented my examining the character of the tentacles and the internal anatomy, especially to learn if the sexual organs be separated, as in *Veronicella* and *Vaginulus*.

Onchidella Carpenteri, W. G. Binn.

Gulf of California. Mr. R. E. C. Stearns.

There is no jaw, which fact renders still more doubtful the presence of one in *Onchidella borealis* as published by me in Terr. Moll. U. S., V. 178.

The lingual dentition is of the same type as that of *O. borealis* (l. c.). The upper margin of the base of attachment is still more prolonged in *O. Carpenteri.*

Zonites Whitneyi, Newcomb.

On p. 432 of Terr. Moll. of United States, Vol. V., will be found a description of the dentition of this species, which is figured here (Pl. I. Fig. I) by showing a central with its adjacent lateral and one marginal tooth.

Zonites subplanus, Binney.

At the same locality where Miss Law found *Vitrinizonites latissimus* (q. v.) she found several specimens of *Zonites subplanus*, a dark, almost black variety. As would be anticipated, the species has the same dentition as *Zonites inornatus*, to which it is nearly allied.

Janulus stephanophora, Desh.

Madeira. Dr. Hillebrand to Dr. Newcomb.

Jaw strongly arched, ends pointed, cutting margin with a sharp, greatly produced median projection.

Lingual membrane not observed.

Janulus bifrons, Lowe.

Madeira. Dr. Hillebrand to Dr. Newcomb.

Jaw smooth with median projection.

Lingual membrane with 34–1–34 teeth, of which 4 on each side are laterals. All as in *Zonites*, i. e. centrals tricuspid, laterals bicuspid, marginals aculeate.

VITRINIZONITES, n. g.

Animal heliciform, blunt before, in motion greatly acuminated behind: mantle subcentral, protected by an external shell: two longitudinal furrows above the margin of the foot, meeting over a round caudal mucus pore: distinct locomotive disk to foot: external orifice of combined generative organs on right side of body, far behind the eye-peduncles; of respiratory and excretory organs on the right of the mantle under the peristome: jaw smooth with median projection: lingual membrane (Pl. II. Fig. H) as in *Zonites*, central teeth tricuspid, lateral teeth bicuspid, marginals aculeate.

Shell external, Vitrina-like.

The above generic name is proposed for the shell described as *Vitrina latissima* (see Terr. Moll. U. S., V. 136, Fig. 51), as it combines the characters of *Vitrina* and *Zonites*. The animal differs from *Vitrina* by having simple, not bifid marginal teeth to the lingual membrane, and by a caudal mucus pore with longitudinal furrows above the margin of the foot, and by the want of an appendiculate mantle. From *Zonites* it differs only in the form of the shell, though the caudal mucus pore seems to be circular, with projecting process when open, rather than a simple longitudinal slit, as in the *Zonites suppressus*. There appears no developed appendiculate mantle process.

I am indebted to Miss Annie E. Law for the opportunity of examining the specimen. She collected it in June, 1879, at the original locality, Bald Mountain, Blount Co., Tenn., on dividing line with North Carolina. At Washington Co., Tenn., it was found by Dr. Rugel. Mrs. G. Andrews found it on Roan Mountain, in North Carolina (over 6,000 feet), on the dividing line with Carter Co., Tenn.

The lingual membrane is broad and not long, the ends are bluntly truncated. There are about 30 rows of 24–1–24 teeth each, arranged as in *Zonites*. There are six laterals, scarcely one perfect, mostly transition teeth, on each side of the central line; the seventh tooth is a marginal, the twelfth tooth is the largest. Plate II. Fig. H shows all the various forms of teeth on the membrane.

Urocyclus Kirkii, Gray ?

I am indebted to Mr. J. S. Gibbons for the opportunity of examining a curious slug collected by him in Mozambique. He suggests that it may be *Urocyclus Kirkii*, Gray (Proc. Zoöl. Soc., 1864, p. 250). He thus describes, in the Quarterly Journal of Conchology, the living animal: —

"Body slender, tapering, keeled, with a sharply pointed tail; on each side of

dorsum a slight and rounded ridge runs from shield to tail; surface longitudinally sulcate, of a dark orange color; keel and lateral ridges light lemon; the sulci and their anastomosing branches dusky; head semi-pellucid, neck slender and compressed; shield anterior, elongate, very convex from side to side, thin and rounded in front, bluntly rostrate behind; a large swelling rather behind the middle indicates the situation of the shell, the apex of which is sometimes visible through a small longitudinal slit situated on a slight eminence nearly at the end of the posterior portion of the shield; surface is a rich orange, thickly studded with small oval granules of a rich lemon color: respiratory orifice large, $\frac{3}{5}$ from anterior end of shield; eye-peduncles long and slender, semi-transparent, of a dusky orange; head and tentacles very beautifully granulate, granules small, regular, and of a pearly appearance; the margin of the body to the extent of 2 mill. is separated by a slight furrow uncovered by integument, grayish, smooth, and secreting mucus very abundantly; at the tail this margin is 6 mill. in extent and bears a small oval mucus pore; length of pore, when fully extended, 3 mill.

"On bushes at Mozambique, East Africa.

"The slit in the shield is capable of considerable enlargement. Sometimes a good deal of the shell is visible; usually the orifice is so contracted that none of it can be seen.

"A comparison of this mollusk with the animal of the African *Nanina* shows some striking points of resemblance; in both there is a furrow running from head to upper part of mucus pore, below which the surface is smooth and mucus-secreting; the pore is similar, and the caudal spine of *Nanina* is indicated in *Urocyclus* by the peaked termination of the integument behind. Lastly, if we suppose the orifice in the shield of *Urocyclus* to be greatly enlarged, and the rudimentary shell developed, we shall have an arrangement of the shield similar to the collar of *Nanina*, namely, part investing the peristome of shell, and part covering dorsum of body."

The dried carcass, as I received it, is about 32 mill. long. The respiratory orifice seems rather anterior than posterior. The mantle is quite large, with a posterior orifice. The internal plate is simple, 7 mill. long, thin, slightly convex, with posterior nucleus and concentric lines of growth. There is a distinct locomotive disk; longitudinal furrows above the margin of the foot, and a longitudinal caudal mucus pore. The jaw is very low, slightly arcuate, ends scarcely attenuated, blunt, anterior surface without ribs, no median projection to the cutting edge (Pl. II. Fig. C). The lingual membrane (Pl. II. Fig. D) shows a tricuspid central tooth and bicuspid laterals, as in *Zonites*, the marginals are aculeate, the cutting edge bifid.

This slug can hardly belong to *Tennentia*, which has a different shelly plate, a median projection to the cutting edge of its jaw, no opening to the mantle. *Parmarion* is described as very near this slug, but its respiratory orifice is posterior, the caudal pore is more developed, not so linear, in a different position, and apparently with a horn-shaped process; its internal plate has a lateral nucleus, while in our slug it is posterior, and its jaw has a median projection. *Dendrolimax* has a much smaller shelly plate, a horn-shaped caudal process, and median projection to the cutting edge of its jaw. It seems, therefore, best to consider it an *Urocyclus*, as suggested by Mr. Gibbons.

Cionella Gloynei, Gibbons, n. sp.

Under stones at Curaçao. Mr. J. S. Gibbons. (Pl. I. Fig. H.)

Both jaw and lingual membrane are as usual in this genus and its allies. (See Terr. Moll. U. S., V.) The figure gives one central and its adjacent lateral tooth.

Pupa contracta, Say.

To the synonymy add *Pupa Cincinnatiensis*, Judge, Quarterly Journal of Conchology, I. 343, fig., 1878.

Hemitrochus Milleri, Pfr.

Fortune Island, Bahamas. Dr. J. J. Brown to Mr. Bland.

Jaw arched, high, ends blunt, scarcely acuminated: anterior surface with one single rib-like prominence, extended into a decided median projection to the cutting edge of the jaw. (Pl. I. Fig. B.)

Lingual membrane with about 33–1–33 teeth. Pl. I. Fig. A shows the gradual change from centrals to extreme marginals. The same type of teeth has been noticed by me in *varians*, *Troscheli*, *graminicola*, and *gallopavonis*. These species differ, however, from *Milleri* by having no rib-like prominence on the anterior surface of their jaw, but a simple median projection to its cutting edge. Like variation as to the presence or absence of ribs on the jaw has been noticed by me in *Dentellaria* and other genera, a fact throwing doubt on the value of the character of ribs on the jaw as of generic weight.

Plagioptycha Duclosiana, Fér.

Exuma, Bahamas. Dr. J. J. Brown to Mr. Bland.

Jaw as described under *Hemitrochus Milleri*.

Lingual membrane with about 30–1–30 teeth. The changes from central to marginal teeth are shown in Pl. I. Fig. C.

Microphysa Stearnsi, Bl.

Olympia, Washington Territory. H. Hemphill.

From an examination of the jaw and lingual dentition it appears that this species is not a *Zonites*, as originally described, but rather a *Microphysa*, like *M. Lansingi* and *M. Ingersolli*. With the former it shares the peculiarity of having a ribbed jaw and aculeate marginal teeth to its lingual membrane. (See Terr. Moll., V. 172, Fig. 21.)

The jaw has over 19 ribs of the same type as those of *M. Lansingi* (l. c.). (See Pl. I. Fig. N.) A portion only of the jaw is figured.

The lingual membrane (Pl. I. Fig. M) has four laterals on each side of the central tooth.

Triodopsis vultuosa, Gould.

Texas. Professor A. G. Wetherby. On Pl. II. Fig. C, is given a figure of the dentition of this species, which I have described on p. 313 of Terr. Moll. U. S., Vol. V.

Mesodon Sayii, Binney, var. Chilhoweensis.

An opportunity of examining the animal of this large form of *M. Sayii*, for which I am indebted to Dr. Lewis, shows that the genital system (Pl. II. Fig. I) is similar to that of the typical form, excepting that the penis sac is still more developed, surpassing by three times the whole genital system in length. (See Terr. Moll. U. S., V., Pl. XI. Fig. 11.)

The jaw and lingual dentition are the same as in the typical *Sayii*. I have figured on Pl. I. Fig. K, the dentition of this variety.

Mesodon devia, Gould.

Freeport, Cowlitz Co., Washington Territory, Mr. Henry Hemphill. On Pl. II. Fig. G, I have figured the genital system of the typical form of this species: *a* is the penis sac; *b*, the genital bladder and duct.

Pomatia Humboldtiana, Val.

The individual examined was considerably smaller than Fig. 1, Pl. XI. of Mollusques Terr. et Fluv. du Mexique. It was collected by Dr. E. Palmer.

The genital system is figured on Pl. II. Fig. J. The genital bladder (*g. b.*) is small, on a long narrow duct; the penis sac (*p. s.*) is long, tapering to a flagellate point, and receives the vas deferens (*v. d.*) about its middle; there is a prostate gland (*pr.*) on a short peduncle, globular, with four accessory leaflets clinging to its base, giving a general rosette-like form to the gland.

The jaw is short, arched, bluntly ending, with six broadly separated stout ribs denticulating either margin.

The lingual membrane is long and narrow. Central teeth (Pl. II. Fig. K) pear-shaped, with no side cusps or cutting points; laterals like the centrals, but asymmetrical; marginals with one long inner bifid cutting point and one smaller side cutting point.

Ochthephila tiarella, Webb & Berth.

Madeira. Dr. Hillebrand to Dr. Newcomb. The species is rarely found living.

Jaw low, slightly arcuate, ends scarcely attenuated; anterior surface with about 15 flat, broad, crowded ribs, scarcely denticulating the cutting margin.

Lingual membrane with 21–1–21 teeth of same type as *Plebecula lurida*, q. v. Laterals about 9 on each side of the central.

Ochthephila abjecta, Lowe.

Madeira. Dr. Hillebrand to Dr. Newcomb.

Jaw low, slightly arcuate, ends attenuated; cutting edge with a blunt median projection; no anterior ribs.

Lingual membrane with 24–1–24 teeth, of which about 4 on each side are laterals. Teeth of same type as those of *Plebecula lurida*, q. v.

Tectula lincta, Lowe.

Madeira. Dr. Hillebrand to Dr. Newcomb.

The species is viviparous.

Plebecula lurida, Lowe.

Madeira. Dr. Hillebrand to Dr. Newcomb.

Jaw low, slightly arcuate, ends scarcely attenuated. Anterior surface with about 8 broad, separated ribs.

Lingual membrane (Pl. I. Fig. L) with 32–1–32 teeth, of the usual *Helicea* type. It will be seen in the figures that the change from lateral to marginal teeth is formed with the splitting of the inner cutting point.

Leptaxis undata, Lowe.

Madeira. Dr. Hillebrand to Dr. Newcomb.

The jaw is described by Mörch as narrow, with numerous ribs converging to centre.

Lingual membrane of the individual examined peculiarly abnormal, the malformed teeth, as figured by me (Pl. I. Fig. E), being repeated often on each transverse row, and down the whole length of the lingual membrane. Such malformations are often found in lingual membranes. Fig. *a* seems to be a normal lateral tooth.

Veronicella ————.

Mozambique. Mr. J. S. Gibbons.

Jaw as usual in the genus ; over 22 ribs.

Lingual membrane as usual in the genus. (See Terrestrial Mollusks of United States, V. 240, Pl. V. Fig. P.)

Veronicella olivacea, Stearns.

Polvon, Occidental Department, Nicaragua, McNiel.

I am indebted to Professor F. W. Putnam for some of the original specimens of this species, which Mr. Stearns has also collected in California.

The jaw is as usual in the genus, with over 20 ribs.

The lingual membrane is also as usual in the genus, as described and figured by me in Terr. Moll. U. S., V. 240, Pl. V. Fig. P.

HEMPHILLIA.

I am indebted to Mr. H. Hemphill for specimens of *Hemphillia glandulosa* from Portland, Oregon, much larger than those first obtained by him, being in their contracted state over 40 mill. long. The shell is not external, as described from the small specimens first received (Terr. Moll. U. S., V.), but is quite covered by the mantle, excepting at the perforation, which is 8 mill. long by 5 broad. Fig. F of Pl. II. gives an outline of this specimen.

Simpulopsis corrugatus, Guppy.

Trinidad. Mr. Guppy to Mr. Bland.

Jaw not observed. Lingual membrane (Pl. I. Fig. G) of the same type as figure, for *S. sulculosus*, by Heynemann, Malak, Blatt., XV., Pl. V. Fig. 10. I find the central teeth in this species distinctly tricuspid.

Bulimulus Schiedeanus, Pfr. (Thaumastus.)

Texas. Professor A. G. Wetherby.

Jaw slightly arcuate, ends scarcely attenuated, blunt; anterior surface with 17 ribs, denticulating either margin. It is difficult to decide the exact character of these ribs. I have usually called the ribs in *Bulimulus*, *Cylindrella*, etc. narrow and widely separated. They should, perhaps, be described as very broad, with narrow interstices, and with a gradual increase of thickness towards their outer longitudinal margin. This plainly thickened margin is what I have formerly described as narrow ribs. In the jaw before me there is no tendency to oblique arrangement of the ribs at the upper central portion of the jaw.

The lingual membrane is long and narrow. Teeth of the same type as described by me under *Bul. dealbatus*, Say, in Terr. Moll. U. S., V. (See Pl. I. Fig. T.)

Bulimulus immaculatus, Ad. (Thaumastus).

Jamaica. Mr. Bland from Mr. Gloyne.

Jaw as usual in the genus with over 36 ribs.

Lingual membrane (Pl. I. Fig. D) as in *B. laticinctus*, *Bahamensis*, *auris-leporis*, *papyraceus*, *membranaceus*, &c. Teeth very numerous; *b* shows a marginal tooth.

Macroceramus inermis, Gundl.?

Curaçao. Mr. J. S. Gibbons.

Lingual membrane as in *Macr. Gossei* (see Terr. Moll. U. S., V. 386, Pl. X. Fig. Q).

Cylindrella Chemnitziana, Fér.

Jamaica. Mr. Thomas Bland.

The lingual membrane is of the same type as the other species of the subgenus *Cylindrella*, s. s., described and figured by Crosse and Fischer (Journ. de Conch., 1870, Pl. IV. Fig. 1).

There are 10–1–10 teeth, with two laterals on each side of the central tooth.

Omalonyx felina, Guppy.

Demarara. Mr. J. S. Gibbons to Mr. Bland.

Jaw as usual in the genus.

Lingual membrane (Pl. I. Fig. J) quite similar to that observed by me in individuals of the same species from Trinidad (Ann. Lyc. Nat. Hist. of New York, X. 346). Mr. Bland and myself have expressed our opinion (l. c.) that *felina* is identical with *O. unguis*.

HAVING from time to time published descriptions of the jaw and lingual dentition of numerous species of terrestrial mollusca, I have considered that a full list of the species would be of value for reference. Abbreviated references are made to the Terrestrial Air-Breathing Mollusks and Shells of the United States, Vol. V.; the Proceedings of the Academy of Natural Sciences of Philadelphia; Annals of the Lyceum of Natural History of New York; and the American Journal of Conchology. A complete list of my writings is given at the end of this paper. In the following catalogue the list of species is complete, but references are given only to the fullest description when the species has been treated in several publications. No reference to figures is given, though almost every species has been figured in the place referred to.

Many of the species were described in connection with Mr. T. Bland.

PULMONATA GEOPHILA.

Agnatha.

Chlamydephorus Gibbonsi. See this paper.
Glandina rosea, FÉR. Am. Journ. Conch., VI. 202.
    solidula, PFR. Ann., X. 347.
    semitarum, RANG. Phila. Ac. Proc. 1874, 49.
    Phillipsi, AD. " " "
    truncata, GMEL. Terr. Moll., V.
    Albersi, PFR. L. & Fr. Water Shells of N. A., I. 19.
    ? ———. Ann. N. Y. Acad., I. 261. (= *aurata*, MOR.)
Gonospira sulcata, MÜLL. Ann., X. 222.
    palanga, FÉR. Am. Journ. Conch., V. 37.
    Newtoni, H. ADAMS. Phila. Proc., 1874, 47.
    Mauritiana, MOR. " " 47.
    modiolus, FÉR. " " 47.
    Nevilli, H. ADAMS. " " 48.
Ennea clavulata, LAM. " " 48.
Onchidium Schrammi, BLAND & BINN. Ann. Lyc., X. 339.
Onchidella borealis, DALL. Terr. Moll., V.
    Carpenteri, W. G. B. See this paper.

Holognatha Vitrinea.

Limax maximus, LIN. Terr. Moll., V.
    flavus, LIN. " "
    agrestis, LIN. " "
    campestris, BINN. " "
    Hewstoni, J. G. COOP. " "
    montanus, ING. Ann., XI. 169.

Limax castaneus, Ing. Terr. Moll., V.
semitectus, Mörch. Ann. N. Y. Acad. Nat. Sc., I. 260.
Urocyclus Kirkii, Gray. See this paper.
Vitrina limpida, Gould. Terr. Moll., V.
Pfeifferi, Newc. " "
exilis, Mor. " "
Nanina Chamissoi, Pfr. Ann., X. 338; Phila., 1874, 248.
radians, Pfr. Ann., XI. 168.
conula, Pse. "
calculosa, Gld. "
subcircula, Mouss. Phila., 1875, 248.
calias, Bens. Am. Journ. Conch., VII. 188.
cultrata, Gould. " " VII. 189.
inversicolor, Fér. Ann. X., 169.
leucostyla, Pfr. "
rufizonata, H. Ad. "
militaris, Pfr. "
Caldwelli, Bens. Phila., 1874, 48.
Rawsonis, Barclay. " "
argentea, Reeve. Phila. 1875, 48.
implicata, Nevill. " "
stylodon, Pfr. " "
philyrina, Morel. " "
Velifera Gabbi, W. G. B. Ann. N. Y. Acad. Nat. Sc., I. 258.
Trochomorpha Cressida, Gld. Ann., XI. 165.
Macrocyclis Baudoni, Pet. Ann., X. 305; Am. Journ. Conch., VII. 174.
euspira, Pfr. Phila., 1875, 247.
Vancouverensis, Lea. Terr. Moll., V.
sportella, Gld. " "
concava, Say. " "
Voyana, Newc. " "
Duranti, Newc. " "
Vitrinizonites latissimus, Lewis. See this paper.
Zonites Bermudensis, Pfr. Phila., 1876, 183; Ann. Lyc., X. 221.
capnodes, W. G. B. Terr. Moll., V.
fuliginosus, Griff. " "
friabilis, W. G. B. " "
lævigatus, Pfr. " "
demissus, Binn. " "
" var. *acerrus*, Lewis. " "
ligerus, Say. " "
intertextus, Binn. " "
inornatus, Say. " "
subplanus, Binn. See this paper.
sculptilis, Bl. Terr. Moll., V.

Zonites Elliotti, REDF. Terr. Moll., V.
cerinoideus, ANTH. " "
cellarius, MÜLL. " "
Whitneyi, NEWC. " " and this paper.
nitidus, MÜLL. " "
arboreus, SAY. " "
viridulus, MÜLL. " "
indentatus, SAY. " "
limatulus, WARD. " "
minusculus, BINN. " "
milium, MORSE. " "
Binneyanus, MORSE. " "
ferreus, MORSE. " "
exiguus, STIMPSON. " "
placentula, SHUTTL. " "
fulvus, DRAP. " "
Gundlachi, PFR. " "
gularis, SAY. " "
suppressus, SAY. " "
lasmodon, PH. " "
significans, BL. " "
internus, SAY. " "
multidentatus, BINN. " "
Janulus bifrons, LOWE. See this paper.
stephanophora, DESH. See this paper.

Holognatha Helicea.

(*a.*) JAW RIBLESS.

Tebennophorus Caroliniensis, BOSC. Terr. Moll., V.
Costaricensis, MÖRCH? Ann. N. Y. Acad. Nat. Sc., I. 261.
Sagda connectens, AD. Am. Journ. Conch., VII. 175.
Haldemaniana, AD. Am. Journ., VII. 175; Phila. Proc., 1874, 55.
Jayana, AD. Ann. Lyc., X. 219.
Endodonta tumuloides, GARRETT. Phila. Proc., 1875, 248.
incerta, MOUSSON. Ann. Lyc., XI. 171.
Microphysa. See below.
Patula Huahinensis, PFR. Ann. Lyc., XI. 171.
solitaria, SAY. Terr. Moll., V.
strigosa, GLD. " "
var. *Cooperi*. " "
Haydeni. " "
Newcombi. " "
Hemphilli, NEWC. " "
Idahoensis, NEWC. " "

Patula alternata, SAY. Terr. Moll., V.
var. *mordax*. " "
Cumberlandiana, LEA. " "
perspectiva, SAY. " "
striatella, ANTHONY. " "
asteriscus, MORSE. " "
Polymita muscarum, LIN. Am. Journ. Conch., VI. 204.
picta, BORN. Ann. Lyc., X. 341.
Hemitrochus gallopavonis, VAL. Ann. Lyc., X. 342.
Troscheli, PFR. " X. 343.
rufoapicata, POEY. " XI. 26.
graminicola, AD. Am. Journ. Conch., VII. 178; Phila. Proc., 1874, 56.
varians, MKE. Terr. Moll., V.
Milleri, PFR. See this paper.
Helicodiscus lineatus, SAY. Terr. Moll., V.
Acavus Phœnix, PFR. Am. Journ. Conch., VII. 180; Phila. Proc., 1874, 58.
Caracolus excellens, PFR. " " " " " " "
sagemon, BECK. Phila. Proc., 1875, 249; 1876, 188.
marginella, GMEL. " 1874, 51.
Arangiana, POEY. " 1875, 250.
Leucochroa Boissieri, CHARP. Ann. Lyc., X. 220; Phila. Proc., 1874, 55.
Ochthephila abjecta, LOWE. See this paper.
tiarella, W. & B. See this paper.
Cysticopsis pemphigodes, PFR. Am. Journ. Conch., VII. 177; Phila. Proc., 1874, 56.
tumida, PFR. Ann. Lyc., IX. 283; Am. Journ. Conch., VI. 203.
Plagioptycha loxodon, PFR. Am. Journ. Conch., VII. 177.
diaphana, LAM. " " " 178.
Albersiana, PFR. " " " 178.
macroglossa, PFR. Phila. Proc., 1874, 56; Am. Journ. Conch., VII. 178.
monodonta, PFR. Am. Journ. Conch., VII. 178.
Duclosiana, FÉR. See this paper.
Leptoloma fuscocincta, AD. Am. Jour. Conch., VII. 180; Phila. Proc., 1874, 58.
Achatinella. Ann. Lyc., X. 331.
picta, MGHLS. Ann. Lyc., X. 331.
jucunda, SMITH. " "
Mastersi, NEWC. " "
nitida, NEWC. " "
grana, NEWC. " "
plumbea, GULICK. " "
eburnea, GULICK. " "
solidissima, SMITH. " "
livida, SWAIN. " "

Achatinella decorticata, Gul. Ann. Lyc., X. 331.
luctuosa, Pfr. " "
nigrolabris, Sm. " "
dimidiata, Pfr. " "
solida, Gul. " "
tæniolata, Pfr. " "
varia, Gul. " "
producta, Rve. " "
Johnsonii, Newc. " "
marmorata, Gld. " XI. 190.
textilis, Fér. " "
obesa, Newc. " "
venusta, Mghls. " "
auricula, Fér. " "
(representing s. g. *Achatinella, Bulimella, Apex, Partulina, Auriculella, Laminella, Amastra, Leptachatina*, of Gulick. For *Carelia*, see below. *Newcombia* not examined.)
Tornatellina aperta, Pse. Ann. Lyc., XI. 189.
oblonga, Pse. " "
Clausilia tridens, Ch. Am. Journ. Conch., VII. 28.
Stenogyra gonostoma, Gundl. " " " 183.
octona, Chemn. " " " 183.
hasta, Pfr. Phila. Proc., 1875, 251.
juncea, Gld. Ann. Lyc., XI. 186.
decollata, Linn. Terr. Moll., V.
subula, Pfr. " "
Strophia incana, Binn. " "
decumana, Fér. Ann. Lyc., X. 348; Phila. Proc., 1874, 53.
mumia, Brug. " X. 348.
iostoma, Pfr. " XI. 31.
Pupa muscorum, L. Terr. Moll., V.
pentodon, S. " "
fallax, S. " "
rupicola, S. " "
corticaria, S. " "
Vertigo Gouldi, Binn. " "
Bollesiana, Morse. " "
ovata, S. " "
ventricosa, Morse. " "
Ferussacia subcylindrica, Lin. Terr. Moll., V.
Cionella Gloynei, Gibbons. See this paper.
Cæcilianella Gundlachi, Pfr. Ann. Lyc., XI. 185.
Holospira Goldfussi, Mke. Terr. Moll., V.
Lithotis rupicola, Blandford. Ann. Lyc., X. 346; Phila. Proc., 1874, 54.
Limicolaria Numidica, Rve. Am. Journ. Conch., VII. 181.

(*b*.) JAW WITH DECIDED STOUT RIBS.

Anadenus ———. Ann. Lyc., XI. 180.
Arion fuscus, MÜLL. Terr. Moll., V.
Geomalacus maculosus, ALLM. Ann. Lyc., X. 308; XI. 31.
Ariolimax Columbianus, GLD. Terr. Moll., V.
Californicus, J. G. C. " "
niger, J. G. C. " "
Hemphilli, W. G. B. " "
Andersoni, W. G. B. " "
Prophysaon Hemphilli, BL. & BINN. " "
" var. " "
Pallifera dorsalis, BINN. " "
Wetherbyi, W. G. B. " "
Veronicella occidentalis, GUILD. Ann. Lyc., X. 339; Am. Jour. Conch., VII. 163.
——— Same.
——— Same.
Floridana, BINN. Terr. Moll., V.
——— ? Ann. N. Y. Acad. Nat. Sc., I. 262.
——— ? See this paper.
olivacea, STRNS. See this paper.
Simpulopsis corrugatus, GUPPY. See this paper.
Binneya notabilis, J. G. C. Terr. Moll., V.
Cryptostrakon Gabbi, W. G. B. Ann. N. Y. Acad. Nat. Sc., I. 260.
Hemphillia glandulosa, BL. & BINN. Terr. Moll., V.
Microphysa circumfirmata, REDF. Ann. Lyc., X. 221. (= Sagda ?)
turbiniformis, PFR. " X. 79; Phila. Proc., 1874, 55.
Stearnsi, BL. See this paper.
Lansingi, BL. Terr. Moll., V.
incrustata, POEY. " "
vortex, PF. " "
Ingersolli, BL. " "
Gonostoma Yatesi, J. G. C. " "
Polygyra microdonta, DESH. Am. Journ. Conch., VI. 205.
auriculata, S. Terr. Moll., V.
uvulifera, SH. " "
auriformis, BL. " "
Postelliana, BL. " "
espiloca, RAV. " "
avara, S. " "
ventrosula, PF. " "
Texasiana, MOR. " "
triodontoides, BL. " "
Mooreana, W. G. B. " "
fastigans, L. W. SAY. " "

Polygyra Troostiana, LEA.	Terr. Moll., V.
Hazardi, BL.	" "
oppilata, MOR.	" "
Dorfeuilliana, LEA.	" "
septemvolva, S.	" "
cereolus, MUHLF.	" "
Carpenteriana, BL.	" "
Febigeri, BL.	" "
pustula, FÉR.	" "
pustuloides, BL.	" "
leporina, GLD.	" "
Polygyrella polygyrella, BL. & C.	" "
Strobila labyrinthica, SAY.	" "
Hubbardi, A. D. B.	" "
Stenotrema spinosum, LEA.	" "
labrosum, BL.	" "
Edvardsi, BL.	" "
barbigerum, REDF.	" "
stenotremum, FÉR.	" "
hirsutum, SAY.	" "
monodon, R.	" "
germanum, GLD.	" "
Triodopsis palliata, S.	" "
obstricta, S.	" "
appressa, S.	" "
inflecta, S.	" "
Rugeli, SH.	" "
tridentata, S.	" "
Harfordiana, J. G. C.	" "
introferens, BL.	" "
Hopetonensis, SH.	" "
Van Nostrandi, BL.	" "
vultuosa, GLD.	See this paper.
loricata, GLD.	Terr. Moll., V.
Mesodon major, BINN.	" "
albolabris, S.	" "
divesta, G.	" "
multilineata, S.	" "
Pennsylvanica, GREEN.	" "
Mitchelliana, LEA.	" "
elevata, S.	" "
Clarki, LEA.	" "
Christyi, BL.	" "
exoleta, BINN.	" "
Wheatleyi, BL.	" "
dentifera, BINN.	" "

Mesodon Roemeri, Pfr. Terr. Moll., V.
Wetherbyi, Bl. " "
thyroides, S. " "
bucculenta, G. " "
clausa, S. " "
Columbiana, Lea. " "
Downieana, Bl. " "
Mobiliana, Lea. " "
devia, G. " " and this paper.
Mullani, Bl. " "
profunda, S. " "
Sayii, Binn. " "
" var. *Chilhoweensis*. See this paper.
Acanthinula harpa, Say. Terr. Moll., V.
Vallonia pulchella, Müll. " "
Fruticicola rufescens, Penn. " "
hispida, Linn. " "
pubescens, Pfr. Ann. Lyc., XI. 172.
Dorcasia pyrozona, Phil. Phila. Proc., 1875, 251.
similaris, Fér. Am. Journ. Conch., VII. 176; Phila. Proc., 1874, 55.
griseola, Pfr. Terr. Moll., V.
Turricula terrestris, Ch. " "
tuberculosa, Conr. Phila. Proc., 1876, 187.
Tectula lincta, Lowe. See this paper.
Aglaja fidelis, Gray. Terr. Moll., V.
infumata, Gld. " "
Arionta arrosa, Gld. " "
Townsendiana, Lea. " "
tudiculata, Binn. " "
Nickliniana, Lea. " "
Ayersiana, Newc. " "
redimita, W. G. B. " "
intercisa, W. G. B. " "
Kelletti, Fbs. " "
Stearnsiana, Gabb. " "
exarata, Pfr. " "
ramentosa, Gld. " "
Californiensis, Lea. " "
Carpenteri, Newc. " "
Mormonum, Pfr. " "
sequoicola, J. G. C. " "
Diabloensis, J. G. C. " "
Traski, Newc. " "
Dupetithouarsi, Desh. " "
intercisa, W. G. B. See this paper.
ruficincta, Newc. Terr. Moll., V.

Arionta Gabbi, Newc. Terr. Moll., V.
Glyptostoma Newberryanum, W. G. Binn. " "
Euparypha Tryoni, Newc. " "
Tachea hortensis, Müll. " "
Coryda Gossei, Pfr. Am. Journ. Conch., VII. 177; Phila. Proc., 1874, 55.
Plebecula lurida. See this paper.
Leptaxis undata, Lowe. See this paper.
Pomatia aspersa, Müll. Terr. Moll., V.
Sieboldtiana, Phil. Phila. Proc., 1875, 250.
Humboldtiana, Val. See this paper.
Thelidomus provisoria, Pfr. Ann. Lyc., X. 347; Phila. Proc., 1874, 51.
discolor, Fér. " XI. 27; " " 56.
aspera, Fér. " XI. 173; Am. Journ. Conch., VI. 204.
Jamaicensis, Chemn. " XI. 173.
notabilis, Shuttl. Phila. Proc., 1874, 50; Am. Journ. Conch., [VII. 177.
lima, Fér. Phila. Proc., 1874, 51.
auricoma, Fér. " 1875, 248.
Arangiana, Poey. " " 250.
Eurycratera angulata, Fér. " 1874, 50.
crispata, Pfr. Phila. Proc., 1874, 50; Am. Journ. Conch., VII. 179; Ann. Lyc., XI. 174.
Polydontes Luquillensis, Shuttl. Phila. Proc., 1874, 50.
Stylodon Studeriana, Fér. Ann. Lyc., XI. 172.
Dentellaria dentiens, Pfr. " XI. 173; Am. Journ. Conch., VII. 179.
pachygastra, Gr. " X. 305.
Josephinæ, Fér. " X. 306; XI. 27.
punctata, Born. Phila. Proc., 1874, 52.
nucleola, Rang. Ann. Lyc., XI. 27; Phila. Proc., 1874, 52.
formosa, Fér. Phila. Proc., 1874, 52.
badia, Fér. " " 52; Ann. Lyc., XI. 26.
nuxdenticulata, Chemn. Ann. Lyc., XI. 26.
lychnuchus, Müll. " X. 301.
orbiculata, Fér. Am. Journ. Conch., VI. 305.
Isabella, Fér. " " VII. 179.
perplexa, Fér. Ann. Lyc., X. 221.
Pleurodonta invalida, Ad. " " 306.
Chemnitziana, Pfr. Phila. Proc., 1874, 51.
Carmelita, Fér. " "
Schroeteriana, Pfr. Am. Journ. Conch., VII. 179.
acuta, Lam. " " VI. 204.
Merope fringilla, Pfr. Ann. Lyc. XI. 175.

Incertæ Sedis.

Helix astur, Souv. Phila. Proc., 1875, 248.
convicta, Cox. " " 251.

Helix ——— ? Ann. N. Y. Acad. Nat. Sc., I. 261.
Carelia bicolor, JAY. Phila. Proc., 1876, 185.
Macrodontes odontostomus, SOWB. Am. Journ. Conch., VI. 209; Phila. Proc., 1874, 58.
Pelocychilus auris Sileni, BORN. Ann. Lyc., XI. 33; X. 222; Phila. Proc., 1874, 58.
glaber, GMEL. Phila. Proc., 1874, 58; Ann. Lyc., XI. 33.
Anthinus multicolor, RANG. Am. Journ. Conch., VI. 203; Phila. Proc., 1874, 58.
Pachyotus egregius, JAY. Phila. Proc., 1874, 58.
Borus oblongus, MÜLL. Am. Journ. Conch., VII. 180.
Orphnus foveolatus, RVE. Ann. Lyc., XI. 32.
magnificus, GRAT. Am. Journ. Conch., VI. 208.
Hanleyi, PFR. Phil. Proc., 1874, 59; Am. Journ. Conch., VI. 208.
Dryptus pardalis, FÉR. Am. Journ. Conch., VII. 181.
marmoratus, DUNKER. Phila. Proc., 1874, 59; Am. Journ. Conch., VII. 181.
Eurytus aulacostylus, PFR. Ann. Lyc., X. 222; Phila. Proc., 1874, 59.
Canistrum fulgetrum, BROD. Am. Jour. Conch., VII. 180; Phila. Proc., 1874, 59.

(*c*.) JAW WITH SEPARATE DELICATE RIBS, USUALLY RUNNING OBLIQUELY TOWARDS THE CENTRE.

Gæotis. Ann. Lyc., X. 252.
Amphibulima patula, BRUG. Ann. Lyc., X. 225; Phila. Proc., 1874, 44.
appendiculata, PFR. " " 343, 206; " " 42.
rubescens, DESH. " " 345; " " 45.
Rawsonis, BLAND. " XI. 187.
Drymæus altoperuvianus, RVE. " " 33.
Vincentinus, PFR. Phila. Proc., 1874, 53.
Knorri, PFR. " " "
Lobbii, RVE. Ann. Lyc., XI. 35.
Bahamensis, PFR. " X. 82.
Rawsonis, H. AD. (*aureolus* var. *Rawsonis*.) Am. Journ. Conch., VII. 181.
Liostracus multifasciatus, LAM. Ann. Lyc., X. 305.
alternans, BECK. " "
Marielinus, POEY. Terr. Moll., V.
Dormani, W. G. B. " "
Mesembrinus primularis, RVE. Ann. Lyc., XI. 37; IX. 282.
pallidior, SOWB. " XI. 180; "
chrysalis, PFR. Phila. Proc., 1874, 53.
Thaumastus alternatus, SAY. Terr. Moll., V.
Schiedeanus, PFR. " " and this paper.
immaculatus, AD. See this paper.
Mormus membranaceus, PHIL. Am. Journ. Conch., VII. 182.
laticinctus, GUPPY. Ann. Lyc., X. 81.

Mormus sufflatus, GLD. Am. Journ. Conch., VI. 209.
Jonasi, PFR. Am. Journ. Conch., VII. 182.
Scutalus rhodolarynx, RVE. Ann. Lyc., XI. 36.
proteus, SOWB. " XI. 37.
dealbatus, SAY. Terr. Moll., V.
Leptomerus limnœoides, FÉR. Ann. Lyc., XI. 186.
sepulcralis, POEY. " X. 347.
corneus, (*Berendti*). Am. Journ. Conch., VII. 182.
Rhinus durus, SPIX. " " "
Plectostylus Peruvianus, BRUG. Phila. Proc., 1874, 53; Ann. Lyc., XI. 35.
Bulimulus (subgenus unknown to me).
Edvardsi, MOREL. Phila. Proc., 1876, 101.
Irazuensis, ANGAS. Ann. N. Y. Ac. Nat. Sc., I. 262. (= Gabbianus.)
Cylindrella elegans, PFR. Phila. Proc., 1875, 251.
cyclostoma, PFR. " " 252.
Humboldti, PFR. " " 252.
ornata, GUNDL. Ann. Lyc., XI. 187.
subula, FÉR. Am. Journ. Conch., VII. 183.
seminuda, AD. " " VII. 184.
rosea, PFR. " " V. 37.
Poeyana, D'ORB. Terr. Moll., V.
Chemnitziana, FÉR. See this paper.
sanguinea, PFR. Ann. Lyc., XI. 34.
brevis, PFR. " "
Macroceramus Gossei, PFR. Terr. Moll., V.
turricula, PFR. Phila. Proc., 1875, 251.
inermis, GUNDL. See this paper.
Pineria Viequensis, PFR. Ann. Lyc., X. 26.
Partula (numerous species). Phila. Proc., 1875, 244; Ann. Lyc., XI. 45.

Elasmognatha.

Omalonyx felina, GUPPY. Ann. Lyc., X. 346, and this paper.
Succinea pallida, PFR. " XI. 189.
papillata, PFR. " "
canella, GLD. " X. 338.
Barbadensis, GUILD. Phila. Proc., 1874, 54.
Haydeni, W. G. B. Terr. Moll., V.
Sillimani, BL. " "
ovalis, GLD., not SAY. " "
Concordialis, GLD. " "
lineata, W. G. B. " "
avara, SAY. " "
Stretchiana, BL. " "
Verrilli, BL. " "
obliqua, SAY. " "
Totteniana, LEA. " "

Succinea campestris, SAY. Terr. Moll., V.
Nuttalliana, LEA. " "
effusa, SH. " "
sagra, D'ORB. Am. Journ. Conch., VII. 184.

Goniognatha.

Orthalicus obductus, SHUTTL. Ann. Lyc., XI. 40.
gallina-sultana, CHEMN. " XI. 38.
undatus, BRUG. Terr. Moll., V.
zebra, MÜLL. Am. Journ. Conch., VI. 212. (= *melanocheilus*, VAL.)
Liguus virgineus, LIN. " " VI. 209; Ann. Lyc., XI. 41.
fasciatus, MÜLL. Terr. Moll., V.

PULMONATA LIMNOPHILA.

Melampus bidentatus, SAY. Ann. Lyc. N. H. of N. Y., IX. 286.
Alexia myosotis, DR. L. & Fr. W. Sh. N. A., II. 1.
Carychium exiguum, SAY. " " " 6.
Limnæa appressa, SAY. Am. Journ. Conch., VII. 161; L. & Fr. W. Sh., II. 28.
stagnalis, L. L. & Fr. W. Sh., II. 155.
megasoma, SAY. Am. Journ. Conch., VII. 162.
columella, SAY. L. & Fr. W. Sh. N. A., II. 24.
catascopium, SAY. " " " 55.
Pompholyx effusa, Lea. Am. Journ. Conch., VI. 312.
Physa vinosa, GLD. L. & Fr. W. Sh. N. A., II. 81.
ancillaria, SAY. " " " II. 83.
Physa ———. Ann. Lyc., X. 255.
Planorbis trivolvis, SAY. Ann. Lyc., IX. 292.
Ancylus Newberryi, LEA. L. & Fr. W. Sh. N. A., II. 22.
Erinna Newcombi, A. AD. Ann. Lyc., X. 349; Phila. Proc., 1874, 54.
Gundlachia Californica, ROWELL. L. & Fr. W. Sh. N. A., II. 148.

PECTINIBRANCHIATA.

Geomelania. Am. Journ. Conch. VII. 185.
Blandiella reclusa, GUPPY. " " "
Megalomastoma bituberculatum, SOWB. Am. Journ. Conch., VI. 213.
Tulotoma magnificum, CONRAD. Ann. Lyc., IX. 293.
Pomus depressa, SAY. L. & Fr. W. Sh., III. 1.
Vivipara intertexta, SAY. " " III. 16.
Melantho integra, SAY. " " III. 35.

SCUTIBRANCHIATA.

Neritella reclivata, SAY. L. & Fr. W. Sh., III. 101.
Stoastoma pisum, AD. Am. Journ. Conch., VII. 184.
Helicina occulta, SAY. Ann. Lyc., IX. 287; Am. Journ. Conch., VII. 29.
———. L. & Fr. W. Sh., III. 116.
orbiculata, SAY. Am. Journ. Conch., VI. 214.

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13. Catalogue of Land and Fresh-water Univalve Mollusks collected in British America, by Messrs. Ross, Kennicott, and Drexler, and deposited in the Smithsonian Collection, from Proc. Philadelphia Acad. Nat. Sci., 1861, p. 330 59
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16. Synopsis of Air-breathing Mollusks of North America, published like the last, Dec. 9, 1863, pp. 12 71
17. Note on the Jaws of Helices, from American Journal of Conchology, I. 47, Pl. VI., 1865 93
18. Description of the Genus *Ariolimax*, Mörch, from same, p. 48, Pl. VI. 94
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36. On the Lingual Dentition of *Blandiella*, *Geomelania*, and *Amphibulima* (in connection with Mr. Bland), from same, pp. 185, 186, Pl. XVII. 221
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39. On the Generic Position of *Helix Newberryana* (in connection with Mr. Bland), from same, pp. 190, 191, Pl. XVII. 226

40. Notes on Lingual Dentition of Certain Species of North American Land Shells (in connection with Mr. BLAND), from Proc. Phila. Acad. Nat. Sci., 1872, pp. 135–137 231
41. On the Relations of Certain Genera of Terrestrial Mollusca of, or related to, the Sub-family *Succininæ*, with Notes on the Lingual Dentition of *Succinea appendiculata*, Pfr. (in connection with Mr. BLAND), from Annals of Lyceum of Nat. Hist. of New York, X., pp. 198–207, Pl. IX., Dec. 1872 (actually distributed Jan. 1873). . 236
42. Description of *Hemphillia*, a new Genus of Terrestrial Mollusks (in connection with Mr. BLAND), same as last, pp. 208–211, Pl. IX. (actually distributed with last) 247
43. On the Lingual Dentition of Certain Terrestrial Mollusca, foreign to the United States (in connection with Mr. BLAND), from same as last, Dec. 1872, pp. 219–225 (actually distributed Jan. 1873) . . 253
44. On the Lingual Dentition of *Gœotis* (in connection with Mr. BLAND), from same as last, pp. 252 - 254, Pl. XI., Jan. 1873 (actually distributed in March) 260
45. Note on a Curious Form of Lingual Dentition in *Physa* (in connection with Mr. BLAND), from same as last (distributed with last), pp. 255–257, Pl. XI. 265
46. On the Lingual Dentition and Jaw of Certain Terrestrial Pulmonata from the United States, with Remarks on their Systematic Value (in connection with Mr. BLAND), from Proc. Phila. Acad. Nat. Sci., 1873 (actually distributed in June), pp. 240–256, Pl. VII. . . 270
47. On *Prophysaon*, a new Pulmonate Mollusk, on *Ariolimax*, on *Helix lychnuchus*, and other species (in connection with Mr. BLAND), from Annals of Lyceum of Nat. Hist. of New York, X., pp. 293–311, Pl. XIII., XIV., 1873 (actually distributed in August) . . . 289
48. Catalogue of the Terrestrial Air-breathing Mollusks of North America, with Notes on their Geographical Range, from Bulletin of Museum of Comparative Zoölogy, Vol. III., No. 9, 1873, pp. 191–220, with a Map (actually distributed in October) 313
49. On the Lingual Dentition and Anatomy of *Achatinella*, and other Pulmonata (in connection with Mr. BLAND), from same as No. 47, pp. 331-351, Pl. XV., XVI., 1873 (actually distributed February, 1874) 345
50. Title-page and Table of Contents to Notes, etc., Vol. I., 1874 . . i

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Vol. II. of my "Notes" contains the following (date of title and index, 1876) :—

PART I.

No. 51. On the Anatomy and Lingual Dentition of *Ariolimax* and other Pulmonata; from Proceedings of the Academy of Natural Sciences of Philadelphia, 1874, pp. 33–63, Pl, II.–XI. (actually distributed May, 1874).

PART II.

No. 52. On the Genitalia and Lingual Dentition of Pulmonata, from the Annals of the Lyceum of Natural History of New York, Vol. XI., June, 1874, pp. 20–46, Pl. I.–VI. (actually distributed Sept., 1874).

PART III.

No. 53. On the Jaw and Lingual Dentition of North American Terrestrial Pulmonata, from same as Part I., 1875, pp. 140–243, Pl. I.–XVIII. (actually distributed Sept., 1875).

No. 54. On the Lingual Dentition and Genitalia of *Partula* and other Pulmonata, from same as last, pp. 244–254, Pl. XIX.–XXI. (distributed with the last).

PART IV.

No. 55. On the Genitalia, Jaw, and Lingual Dentition of Certain Species of Pulmonata, from same as No. 52, Vol. XI. pp. 166–196, Pl. XII.–XVIII., October, 1875 (actually distributed March, 1876).

Vol. III of my "Notes" has thus far only the following: —

56. On the Lingual Dentition, Jaw, and Genitalia of Carelia, Onchidella, and other Pulmonata, from the Proceedings of the Philadelphia Academy of Natural Sciences, 1876, pp. 183–192, Pl. VI.
57. On the Land Shells of the Mexican Island of Guadelupe, collected by Dr. E. Palmer, from same, 1879, p. 16.
58. On the Jaw and Lingual Dentition of certain Costa Rica Land Shells, collected by Dr. W. M. Gabb, from Annals of New York Academy of Sciences, Vol. I. pp. 257–262, Pl. XI., 1879.
59. This paper.

In addition to the above papers, I have published the following articles, of which extra copies have not been distributed: —

60. Note on *Helix thyroides*, Proc. Boston Soc. Nat. Hist., April, 1857, VI, 128, 129.
61. Descriptions of two supposed new species of American Land Shells, from same, Vol. VI. pp. 155, 156, 1857.
62. Note on Geographical Distribution of North American Land Shells, from same, Vol. IX. pp. 177, 1863.
63. On Lingual Dentition studied by the Microscope and Photography, from American Journal of Conchology, Vol. V. pp. 37, 38, Pl. XI., 1869, with a note by Mr. BLAND.
64. Notes sur quelques espèces de mollusques fluviatiles de l'Amérique du Nord. From Journal de Conchologie, Vol. XX. (3d series, Vol. VII.) Paris, 1867, pp. 427–432.

65. Catalogue of Land Shells, p. 725. From Explorations in Nebraska. Preliminary Report of Lieut. G. K. Warren, Top. Eng., etc. Dr. F. V. Hayden's Report on Geology and Natural History. From Executive Documents, printed by order of the House of Representatives, during the Second Session of the 35th Congress, 1858–59, Vol. II. Part III. pp. 723. Washington, 1859.
66. Report on the Land Shells collected on the Survey, from Reports of Explorations and Surveys to ascertain the most practicable and economical Route from the Mississippi River to the Pacific Ocean, made under the direction of the Secretary of War, in 1854–5, Vol. VI. pp. 111–114. Washington, 1857.
67. The Terrestrial Air-breathing Mollusks of the United States, Vol. IV. pp. 207, and six colored Plates, forming also Part I. of Vol. VII. of the Boston Journal of Natural History. Westermann & Co., New York, 1859. — The same, Vol. V., pp. 449, sixteen new plates, and plates of Vol. III. reproduced. Published as Bulletin of the Museum of Comparative Zoölogy at Cambridge, Mass., Vol. IV., July, 1878.
68. Land and Fresh-water Shells of North America. Part II. Pulmonata Limnophila and Thalassophila, pp. 161 and wood-cuts, from Smithsonian Miscellaneous Collections. Washington, 1865.
69. Part III. of same: Ampullariidæ, Valvatidæ, Viviparidæ, Fresh-water Rissoidæ, Cyclophoridæ, Truncatellidæ, Fresh-water Neritidæ, Helicinidæ, pp. 120 and wood-cuts, 1865.
70. Part I of same: Pulmonata Geophila (in connection with Mr. Bland), pp. 316 and wood-cuts, 1869.
71. Report on the Invertebrata of Massachusetts, by A. A. Gould, M. D. Second Edition. Boston, 1870, pp. 524, wood-cuts, and eleven colored plates.
72. The Complete Writings of Thomas Say on the Conchology of the United States. New York, H. Baillière, 1858, pp. 252, 74 plates. The "Descriptions of Terrestrial Shells of North America" were published separately in 1856. Philadelphia, Childs & Peterson, pp. 40.
73. The Complete Writings of Constantine Smaltz Rafinesque, on Recent and Fossil Conchology (in connection with G. W. Tryon, Jr.). New York, Ballière Bros., 1864, pp. 96, wood-cuts and 3 plates.
74. The Bibliography of North American Conchology, previous to the year 1860. From Smithsonian Miscellaneous Collections. Washington, Part I., pp. 650, 1863.
75. The same, Part II., pp. 298, 1864.

EXPLANATION OF THE PLATES.

Plate I.

Fig. A. Lingual dentition of Hemitrochus Milleri, Pfr.
Fig. B. Jaw of same.
Fig. C. Lingual dentition of Plagioptycha Duclosiana, Fér.
Fig. D. " " Bulimulus immaculatus ; *b*, a marginal tooth.
Fig. E. " " Leptaxis undata, Lowe.
Fig. F. " " Bulimulus Schiedeanus, Pfr.
Fig. G. " " Simpulopsis corrugatus, Guppy.
Fig. H. " " Cionella Gloynei, Gibbons.
Fig. I. " " Zonites Whitneyi, Newc.
Fig. J. " " Omalonyx felina, Guppy.
Fig. K. " " Mesodon Chilhoweensis, Lewis.
Fig. L. " " Plebecula lurida, Lowe.
Fig. M. " " Microphysa Stearnsi, Bl.
Fig. N. Jaw of same.

Plate II.

Fig. A. Chlamydephorus Gibbonsi.
Fig. B. " " lingual dentition.
Fig. C. Triodopsis vultuosa, Gld., lingual dentition.
Fig. D. Urocyclus Kirki, Gray, jaw.
Fig. E. " " " lingual dentition.
Fig. F. Hemphillia glandulosa.
Fig. G. Genitalia of Mesodon devia, Gld. ; *a*, penis sac ; *b*, genital bladder and duct.
Fig. H. Vitrinizonites latissimus, Lewis, lingual dentition.
Fig. I. Genitalia of Mesodon Sayii, var. Chilhoweensis.
Fig. J. Genitalia of Pomatia Buffoniana, Val.

o. ovary.
a. accessory gland.
e. epididymis.
ov. oviduct.
v. d. vas deferens.
g. b. genital bladder.
pr. prostate gland.
p. s. penis sac.
or. external orifice.

APPENDIX.

Arionta intercisa, W. G. Binn. Mr. Henry Hemphill has lately sent me alcoholic specimens of this species, collected by him at San Clemente Island, California.

The jaw is as usual in the genus, with six separated ribs.

The lingual membrane is as usual in the genus. Teeth 31-1-31, with about 15 laterals on each side. The extreme laterals only are bicuspid.

The genitalia are like those figured by me for *Euparypha Tryoni.* (See Terr. Moll. U. S., V.)

From the series of specimens sent by Mr. Hemphill, I am inclined to believe *Arionta redimita* to be a variety of *intercisa.* The original specimen may have come from the same locality. Formerly I suspected *redimita* to be a variety of *ramentosa.*

NOTE ON THE GENERA OF SLUGS.

Having had occasion to describe several genera of naked terrestrial mollusks, I add here, for the sake of comparison, a list of known genera with their generic characters, as far as they can be ascertained. It is difficult to draw the line between the slugs and the snails. I have not included *Succinea, Helisaga, Amphibulima (Pellicula), Vitrinopsis, Vitrinizonites,* which have some claim to be considered sublimaciform. I have included *Binneya* and *Laconia,* which should, perhaps, be considered as subheliciform.

AGNATHA.

Testacella, Cuv. Animal limaciform, subcylindrical, tapering anteriorly: tentacles simple: mantle small, posterior, quite near tail, covered with a small external shell: no longitudinal furrows above the margin of the foot, and no caudal mucus pore: no distinct locomotive disk: external respiratory and anal orifice at the posterior right edge of the mantle under peristome of the shell: combined generative orifice behind and below the right eye-peduncle.

Shell external, rudimentary, imperforate, ear-shaped, with a subspiral, posterior, umbona nucleus.

No jaw.

Lingual membrane with no central tooth; others aculeate, apex hooked.

Eastern Europe, Teneriffe, Madeira.

For figure of animal and shell, see Moquin-Tandon, Moll. Terr. et Fluv. de la France.

For lingual dentition, see Heynemann, Malak, Blatt., X., Pl. II. Fig. 5.

The body is distinguished by two lateral grooves.

Daudebardia, Hartm. (*Helicophanta*, Fér.) Animal limaciform, subcylindrical, tapering anteriorly: tentacles simple: mantle small, posterior, quite near tail, covered with a small, external shell: longitudinal furrows above the margin of the foot? no caudal mucus pore: distinct locomotive disk? external respiratory and anal orifice at the posterior right margin of mantle, under the peristome of the shell: generative orifice?

Shell small, external, perforate, depressed: paucispiral, whorls rapidly increasing.

No jaw.

Lingual membrane without central teeth; other teeth all aculeate, apex simple.

Germany, Hungary, Switzerland, Northern Italy.

For figure of animal and shell, see H. and A. Adams, Gen. Rec. Moll.

For dentition, see Goldfuss, Naturh. Vereins der Preuss. Rheinl. und Westphalens, 1856, Pl. VI. Figs. C, C'.

For anatomy, see Fischer, Journ. de Conch., V. 13.

The body has two lateral and two dorsal grooves.

Vaginulus, Stol. (*Vaginula* and *Veronicella*, part, of authors.) Animal limaciform, subcylindrical, high on the back, slender and pointed at tail: tentacles bifid: mantle covering the whole back: no longitudinal furrows above the margin of the foot, and no caudal mucus pore: no distinct locomotive disk? external anal and respiratory orifice at the lower right side of the mantle, about two fifths of the length of the body distant from the front: generative orifices distinct, the female with the respiratory orifice as above described, the male orifice behind and below the right eye-peduncle.

No shell.

No jaw.

Lingual membrane short: teeth aculeate.

Cochin China, etc.

For a figure of the animal, see Voyage de la Bonite, Pl. 28, Figs. 4–7, *V. Tourannensis*. For a notice of the agnathous genus as restricted from *Veronicella*, see Stolicska, Journ. Asiatic Soc. Bengal, 2d series, Vol. XLII. No. CLXXXI. p. 33.

Chlamydephorus, W. G. Binn. Animal limaciform, subcylindrical, tapering anteriorly: tentacles simple? mantle covering the whole back, with an orifice on its upper surface, near the tail, with radiating granulations, and near the same point enclosing a shelly plate: longitudinal furrows above the margin of the foot, meeting over a caudal mucus pore: distinct locomotive disk? external respiratory and anal orifice at the opening on the back? generative orifice or orifices?

Shell-plate internal, flat, white, testaceous, heavy, subhexagonal, small.

No jaw.

Lingual membrane quite like that of *Glandina;* central teeth like marginals, but symmetrical; other teeth aculeate.

Natal Colony, Africa.

For figure of animal and dentition, see Bulletin of Museum of Comparative Zoölogy at Cambridge, Pl. II. Fig. A. *Ante*, p. 331.

Onchidium, Buch. Animal limaciform, elongate-oval: tentacles wanting: mouth with lobate appendages: mantle coriaceous, tubercular, covering the whole back: no longitudinal furrows above the margin of the foot, nor caudal mucus pore: no distinct locomotive disk: external respiratory orifice under the right posterior margin of the mantle: anal orifice separate from the last, posterior: male external generative orifice under the right eye-peduncle; female orifice at posterior of under side of body.

No shell or shelly plate.

No jaw.

Lingual membrane broad: teeth different in shape from those of the terrestrial genera, arranged in very oblique rows; centrals tricuspid, side teeth all alike, bicuspid, inner cusp small, outer cusp larger, with a greatly produced, oblique, squarely truncated cutting point.

Bengal, West Indies, etc.

For figure of animal, see Genera of Recent Mollusca; of lingual dentition, see W. G. Binney, Ann. Lyc. Nat. Hist. of N. Y., X., Pl. XVI. Figs. 3-5.

This and the three following genera are marine, and are in many ways distinct from the rest of the *Geophila.*

Onchidella, Gray. Animal ovate: other characters as in *Onchidium,* but mantle smooth or granular.

For figure of animal, see Genera of Recent Mollusca; of lingual dentition, see Binney, Terr. Moll. U. S., V., Pl. V. Fig. B.

Distribution world-wide?

Peronia, Blainv. (*Onchis*, Fér., *Oncus*, Ag.) Animal elongate-ovate; like the last genus, but with arbusculiform tufts and tubercles on mantle.

For figure of animal, see Genera of Recent Mollusca; of lingual dentition, see Keferstein in Bronn's Thierr., CII., Fig. 2.

Buchanania, Lesson. Like the last genus, but mantle smooth, with a large central tubercle and radiating striæ; oral appendages simple, subulate.

Chili.

For figure of animal, see Genera of Recent Mollusca.

Lingual dentition — ?

HOLOGNATHA VITRINEA.

Limax, Linn. Animal attached its whole length to the foot, subcylindrical, tapering behind, bluntly truncated anteriorly: tentacles simple: mantle small, anterior, enclosing a shelly plate: no longitudinal furrows above the margin of the foot, nor caudal mucus pore: a distinct locomotive disk: external anal and

respiratory orifices at the right posterior margin of the mantle: orifice of combined generative organs behind and below the right eye-peduncle.

Shell-plate testaceous, thin, flat, longer than wide, with concentric striæ of increase, internal.

Jaw smooth, with median projection.

Lingual membrane long and narrow : central teeth tricuspid, laterals bicuspid, marginals aculeate, often bifid. Considerable variation is found in the dentition of the genus ; the centrals and laterals are sometimes unicuspid.

Universally distributed.

For figures of animal, shelly plate, jaw, and lingual dentition, see Terr. Moll. U. S., V.

The following generic and subgeneric names have been suggested for species of *Limax*, founded mostly on peculiarities of the mantle, genitalia, and lingual dentition : *Eulimax*, *Agriolimax*, *Milax*, *Amalia*, *Lehmannia*, *Limacus*, *Krynickellus*, *Krynickia*, *Heynemannia*, *Plecticolimax*, *Hydrolimax*, *Lallemannia*, *Malino*, *Malinastrum*, *Gestroa*, *Chromolimax*, *Opilolimax*, *Stabilea*, *Malicolimax*, *Megapelta*, *Clytropelta*, *Ibycus*.

Parmacella, Cuv. (*Cryptella*, Webb & Berth., *Girasia*, *Drusia*, Gray, part.) Animal limaciform, subcylindrical, swollen behind, gradually attenuated before : tentacles simple : mantle large, central, concealing the shell : no longitudinal furrows above the margin of the foot, and no caudal mucus pore : distinct locomotive disk ? external respiratory and anal orifices at the right posterior margin of the mantle : orifice of combined generative organs behind and below the right eye-peduncle.

Shell small, testaceous, internal, rudimentary, subspiral, aperture very large, dilated anteriorly.

Jaw smooth, with a median projection.

Lingual membrane with tricuspid centrals, first laterals tricuspid also, marginals aculeate.

Around the Mediterranean, Canaries, Central Asia.

For figure of animal and jaw see Moquin-Tandon, Moll. Terr. et Fluv. de la France. For description of lingual dentition, see Semper, Phila. Arch., 89.

The young animal is entirely enclosed in the shell, which is furnished with a sort of operculum. As the animal grows, the operculum falls, the shell becomes covered with the mantle, and only increases at its outer margin like the simple shell-plate of *Limax*.

Tennentia, Humb. Body limaciform, subcylindrical, attenuated behind : tentacles simple : mantle large, anterior, concealing the shell : longitudinal furrows above the margin of the foot, meeting over a linear caudal mucus pore : distinct locomotive disk : external respiratory and anal orifices on the right central margin of mantle : orifice of combined genital system behind and below the right eye-peduncle.

Shell internal, small, rudimentary, convex above, flat below, apex on right posterior side, recurved.

Jaw smooth, with median projection.

Lingual membrane with tricuspid centrals and laterals, and aculeate, bifid, marginals, in the typical species ; others vary.

Ceylon.

For figure of animal, jaw, and lingual dentition, see Humbert, Rev. et Mag., 1862, p. 428.

Mariella, Gray (1855), is by some considered identical, and, if so, its name will take precedence. Identical with this last is *Clypeidella*, Val. ms., and *Clypeicella*. *Viquesnelia*, Desh., is also considered identical. (*V. Atlantica*, Mor., has the pulmonary orifice posterior.)

Parmarion, Fischer. (*Rigasia*, Gray.) Animal limaciform, subcylindrical, tapering behind : tentacles simple : mantle large, anterior, enclosing an internal shell-plate, which is partially exposed by a posterior opening : distinct locomotive disk ? longitudinal furrows above the margin of the foot and caudal mucus pore, over which is a horn-shaped process : external anal and respiratory orifices on the posterior right margin of mantle (see Von Martens's figure of *P. papillaris*) : orifice of combined genital system ?

Shell-plate internal, rudimentary, flat, with a side nucleus.

Jaw smooth, with median projection.

Lingual membrane with tricuspid centrals, bicuspid laterals, and aculeate, bifid marginals.

Java, India.

For figure of animal, see Von Martens, Preuss. Ost. Asien ; of jaw and lingual dentition, see Semper, Phil. Arch.

Urocyclus, Gray. Animal limaciform, subcylindrical, blunt before, tapering behind : tentacles simple : mantle small, anterior, with a posterior opening, and concealing an internal shell-plate : longitudinal furrows above the margin of the foot and caudal mucus pore : a distinct locomotive disk : external respiratory and anal orifices on the right slightly anterior margin of the mantle : orifice of combined generative organs behind and below right eye-peduncle.

Shell-plate internal.

Jaw smooth, without median projection.

Lingual membrane with tricuspid centrals, bicuspid laterals, aculeate and bifid marginals.

Mozambique.

For figure of animal, see Ann. Nat. Hist., [3,] XV., 1865, p. 331; of jaw and lingual dentition, see Bull. Mus. Comp. Zoöl., *ante*, p. 333.

Nearly allied to *Parmarion ;* seems only to differ by the position of the respiratory orifice, and the want of a horn-shaped process to the caudal pore.

Dendrolimax, Heynem. Animal limaciform, subcylindrical, blunt before, tapering behind : tentacles simple : mantle small, anterior, concealing an internal shell-plate, perforated posteriorly : longitudinal furrows above the margin of the foot ? a caudal mucus pore, with overhanging horn-shaped process : distinct locomotive disk : anal and respiratory orifices at anterior right edge of

mantle: orifice of combined genital system behind and below right eye-peduncle.

Shell-plate internal, suboval, slightly convex, small, with posterior nucleus and concentric lines of growth.

Jaw smooth, with median projection.

Lingual membrane with peculiarly shaped teeth, centrals tricuspid, laterals bicuspid, marginals aculeate, bicuspid.

Prince's Island.

For figure of animal contracted in spirits, jaw, and lingual dentition, see Heynemann, Malak, Blatt., XV., Pl. I.

The horn-shaped process only seems to distinguish it from *Urocyclus*, the position of the respiratory orifice from *Parmarion*. Dentition peculiar.

Vitrinoidea, Semper. Animal limaciform, swollen at its middle, slender and tapering behind: tentacles simple? mantle large, anterior, covering the shell: no longitudinal furrows above the margin of the foot, and no caudal mucus pore: no distinct locomotive disk: external respiratory and anal orifices on right anterior margin of mantle: orifice of combined genital system behind and under right eye-peduncle.

Shell internal, paucispiral, transparent, globose, rudimentary.

Jaw smooth.

Lingual membrane with tricuspid central and lateral teeth, and tricuspid aculeate marginals.

Luzon.

For figure of animal and lingual dentition, see Semper, Phil. Arch.

HOLOGNATHA HELICEA.

Tebennophorus, Binn. (*Incilaria*, Bens., *Megimathium*, Van Has.) Animal limaciform, cylindrical, blunt before, slightly attenuated behind: tentacles simple: mantle covering the whole back: no longitudinal furrows above the margin of the foot, and no caudal pore: no distinct locomotive disk: external respiratory and anal orifices near the head, somewhat to the rear of the right eye-peduncle: orifice of combined genital system behind and below the right eye-peduncle.

Shell or shell-plate none.

Jaw smooth, with median projection.

Lingual membrane long and narrow, centrals and first laterals unicuspid, outer laterals bicuspid, marginal teeth quadrate.

Asia, North and Central America.

For figure of animal, jaw, and lingual dentition, see Terr. Moll. U. S., V.

Oopelta, Heynem. Body limaciform, subcylindrical, tapering behind: tentacles simple: mantle small, oval, more pointed behind: no longitudinal furrows above the margins of the foot, and no caudal mucus pore: no distinct locomotive disk: external respiratory and anal orifices on the right slightly anterior margin of the mantle: orifice of combined generative system behind and under the right eye-peduncle.

No internal shell-plate.

Jaw smooth, with a median projection.

Lingual membrane with tricuspid centrals, bicuspid laterals, quadrate marginals.

Java, Ceylon, Cape of Good Hope, Guinea.

For figure of lingual dentition, see Heynemann, Malak, Blatt., XIV., Pl. II.

Anadenus, Heynem. Animal limaciform, subcylindrical, tapering behind: tentacles simple: mantle anterior, concealing an internal shell-plate: no longitudinal furrows above the margin of the foot, and no caudal mucus pore: a distinct locomotive disk: external respiratory and anal orifices on the right posterior margin of the mantle; orifice of the combined genital system behind and below the right eye-peduncle.

Internal shell-plate small, oval, flat, with posterior nucleus and concentric striæ.

Jaw with numerous ribs.

Lingual membrane with tricuspid centrals, bicuspid laterals, and quadrate marginals.

Himalaya Mountains.

For figure of shell-plate and lingual dentition, see Heynemann, Malak, Blatt., X., Pl. I.

Arion, Fer. (*Prolepis*, *Lochea*, *Baudonia*, *Kobeltia*.) Animal limaciform, subcylindrical, attenuated behind: tentacles simple: mantle small, anterior, concealing calcareous grains, sometimes agglomerated into a shelly plate: longitudinal furrows above the margins of the foot, meeting over a caudal mucus pore: a distinct locomotive disk: exterior respiratory and anal orifices on the anterior right margin of the mantle; orifice of the combined genital system below the last.

Internal calcareous grains, in some species forming an imperfect shell-plate.

Jaw ribbed.

Lingual membrane with tricuspid central teeth, tricuspid or bicuspid laterals, and quadrate marginals.

Europe.

For figure of animal, jaw, and lingual dentition, see Terr. Moll. U. S., V.

Ariolimax, Mörch. Animal limaciform, subcylindrical, tapering behind: tentacles simple: mantle anterior, small, concealing an internal shell-plate: longitudinal furrows above the margin of the foot, meeting over a caudal mucus pore: a distinct locomotive disk: external respiratory and anal orifices on the posterior right margin of the mantle: orifice of combined genital system on the right side of the body, below the anterior free edge of the mantle.

Shell-plate internal, solid, flat, longer than wide.

Jaw ribbed.

Lingual membrane with tricuspid centrals, bicuspid laterals, and quadrate marginals.

Pacific Coast of United States.

Prophysaon, Bland & Binn. Animal limaciform, subcylindrical, tapering behind: tentacles simple: mantle small, anterior, concealing a shell-plate: no longitudinal furrows above the margin of the foot, and no caudal mucus pore: no distinct locomotive disk: external respiratory and anal orifices on the right anterior margin of the mantle; orifice of combined genital system behind and below the right eye-peduncle.

Internal shell-plate thick, small, flat, longer than wide.

Jaw ribbed.

Lingual membrane with tricuspid centrals, bicuspid laterals, and quadrate marginals.

Pacific Coast of United States.

Pallifera, Morse. Same as *Tebennophorus*, but with ribbed jaw.

In *Hemitrochus* and *Dentellaria* the presence or absence of ribs on the jaw is surely not a generic character. It may be, therefore, that *Pallifera* is identical with *Tebennophorus*.

Veronicella, Blain. (*Vaginula*, Fér., not *Vaginulus*, Stolicska, q. v.) Animal limaciform, elongate-ovate, rounded above, flat below, margins expanded: tentacles bifid, unequal, contractile: mantle covering the whole back: no longitudinal furrows above the margin of the foot, and no caudal mucus pore: no distinct locomotive disk: external respiratory orifice connecting with a tube to the anal orifice at the extreme posterior under part of the animal; orifice of male genital organ at the base of the right tentacle, of the female organs at the middle of the right under-side of the animal.

No internal shell or plate.

Jaw with numerous ribs.

Lingual membrane quite peculiar, marginals quadrate.

For figure of animal, jaw, and lingual dentition, see Terr. Moll. U. S., V.

Asia, Africa, South and North America, in warm latitudes.

Binneya, J. G. Coop. (*Xanthonyx*, Cr. & Fisch.) Animal sublimaciform, blunt before, tapering behind: tentacles simple: mantle subcentral, covered by a shell, with an anterior expansion: no longitudinal furrows above the margin of the foot, and no caudal mucus pore: a distinct locomotive disk: external respiratory and anal orifices on the right posterior margin of the mantle, under the peristome of the shell: orifice of combined genital system behind and below the right eye-peduncle.

Shell external, paucispiral, auriform, not enclosing the animal.

Jaw ribbed.

Lingual membrane with tricuspid central teeth, bicuspid laterals, and quadrate marginals.

Mexico and islands off southern coast of California.

The animal has the peculiarity during estivation of forming a testaceous covering extending from the peristome over the parts not protected by the shell.

The body is not attached its whole length to the foot, the viscera forming a turbinate spiral mass, partially protected by the shell.

Hemphillia, Bl. & Binn. Animal limaciform, blunt before, swollen at centre, and greatly attenuated behind : tentacles simple : mantle subcentral, large, oval, concealing all but a rounded large orifice, an internal shell-plate : longitudinal furrows above the margin of the foot and caudal mucus pore, over which is a hump-like process : no distinct locomotive disk : external respiratory and anal orifices at the central right margin of the mantle : orifice of combined genital system near the right eye-peduncle.

Shell-plate horny, small, unguiform, longer than wide, with posterior nucleus and concentric lines of growth.

Jaw ribbed.

Lingual membrane with tricuspid central teeth, bicuspid laterals, and quadrate marginals.

Coast of Oregon.

The swollen central portion of the animal seems the first approach to a turbinate mass of viscera, separated from the foot.

Geomalacus, Alm. Animal limaciform, subcylindrical, blunt behind : tentacles simple : mantle anterior, close to head, concealing a shell-plate : longitudinal furrows above the margin of the foot ? a caudal mucus pore : a distinct locomotive disk : external respiratory and anal orifices on the right far anterior margin of mantle : orifice of combined genital system behind and below right eye-peduncle.

Shell-plate calcareous, flat, small, internal, ovate.

Jaw ribbed.

Lingual membrane with tricuspid centrals, bicuspid laterals, quadrate marginals.

Eastern Europe.

For figure of the animal and internal shell plate, see Adams's Genera ; of jaw and lingual dentition, see Heynemann, Malak, Blatt., XXI., Nachr. der Malak, Gesell., T. 165, Pl. I.

Letourneuxia, Bourg. Animal limaciform, subcylindrical, scarcely attenuated behind : tentacles simple : mantle small, anterior, concealing a shell-plate : no longitudinal furrows above the margin of the foot, and no caudal mucus pore; no distinct locomotive disk: external respiratory and anal orifices on the right anterior margin of the mantle : orifice of combined genital system ?

Shell-plate internal, calcareous, suboval, flat.

Jaw ribbed.

Lingual membrane ?

Algiers.

There is a peculiar overhanging process to the side of the body, near the tail.

For figure of animal, internal shell-plate, and jaw, see Bourguignat, Moll. Nouv., VII., 1866, p. 201, Pl. XXXIV. Fig. 7.

Peltella, Webb & Van Ben. (*Pectella*, Gray.) Animal limaciform, rounded above, flat below, sides widely expanded : tentacles simple : mantle

small, oval, posterior, concealing a shell : no longitudinal furrows above the margin of the foot, and no caudal mucus pore : distinct locomotive disk ? external respiratory and anal orifices on the right anterior margin of the mantle ; orifice of combined genital organs behind and below right eye-peduncle.

Shell internal, sigaretiform, rudimentary, small, flat, oblong, subspiral, nucleus infero-posterior.

Jaw ribbed.

Lingual membrane —— ?

Brazil.

Until the jaw and dentition be known, its position is uncertain. The former from one of Férussac's figures seems to be costate.

For figure of animal, see Férussac, Hist., Pl. VII. A.

From Férussac's figure 4 it appears probable that the shell may be more properly described as external, but covered by an accessory process of the mantle.

Cryptostrakon, W. G. BINN. Animal limaciform, subcylindrical, attenuated behind : tentacles simple : mantle slightly anterior, thin, small, concealing the shell : no longitudinal furrows above the margin of the foot, and no caudal mucus pore : distinct locomotive disk ? external respiratory and anal orifices on the right central margin of the mantle : orifice of genital organs ?

Shell internal, sigaretiform, rudimentary, large as mantle, membranous, subspiral, with postero-lateral nucleus.

Jaw ribbed.

Lingual membrane with tricuspid central teeth, bicuspid laterals, and quadrate marginals.

Costa Rica.

For figure of animal, internal shell, jaw, and lingual dentition, see Ann. of N. Y. Acad. Nat. Sci., I., Pl. XI.

Gæotis, SHUTTL. Animal limaciform, with greatly expanding, flat sides : tentacles simple : mantle with an appendiculate process on the right posterior margin under the spire of the shell, which is internal, concealed before by a reflection of the mantle, and behind is imbedded in the mantle : longitudinal furrows —— ? caudal pore —— ? distinct locomotive disk ? external respiratory and anal orifices at the right posterior margin of the mantle : orifice of generative organs —— ?

Shell internal, rudimentary, thin, subspiral, sigaretiform.

Jaw with numerous delicate ribs, as in *Cylindrella.*

Lingual membrane with peculiar, long, narrow teeth, centrals bluntly tricuspid, laterals and marginals bluntly tricuspid.

Porto Rico.

For figure of the shell, see Genera of Recent Mollusca, Pl. LXXII. Fig. 6 a ; for jaw and lingual membrane, see Ann. Lyc. Nat. Hist. of N. Y., X., Pl. XI. ; for description of animal, see Shuttleworth, Bern Mit., 1854, p. 34.

The appendiculate mantle and position of the respiratory and anal orifice distinguish it from *Peltella,* and the jaw seems different.

ELASMOGNATHA.

Omalonyx, D'ORB. (*Pelta*, Beck.) Animal limaciform, blunt before, short behind: tentacles simple: mantle large, central, its margins holding the edges of the external shell: no longitudinal furrows above the margin of the foot, and no caudal mucus pore: no distinct locomotive disk: external respiratory and anal orifices on the right central margin of the mantle: generative orifice below and behind the right eye-peduncle.

Shell external, its margins imbedded in the mantle, rudimentary, non-spiral, oval, depressed, unguiform.

Jaw smooth, with median projection and accessory quadrate plate.

Lingual membrane with tricuspid centrals, tricuspid laterals, and multifid quadrate marginals.

West Indies and Brazil.

For figure of animal and shell, see Genera of Recent Mollusca; for jaw and lingual dentition, see Heynemann, Malak, Blatt., 1868.

Hyalimax, H. & A. AD. Animal limaciform, swollen at centre, blunt before, and tapering behind: tentacles simple: mantle large, central, concealing all but a small opening, an internal shell-plate: no longitudinal furrows above the margin of the foot, and no caudal mucus pore: no distinct locomotive disk: external respiratory and anal orifices on the central right margin of the mantle: orifice of combined genital system on right side of head, half-way between eye-peduncle and mantle.

Shell large, rudimentary, thin, oval, unguiform, non-spiral.

Jaw smooth, with blunt median projection and accessory quadrate plate.

Lingual membrane with tricuspid central teeth, multifid laterals, and quadrate marginals.

Mauritius.

For figure of animal, shell, jaw, and lingual dentition, see Fischer, Journ. de Conch., XV. 218, Pl. X.

Specimens from Mauritius examined by myself have the opening in the mantle, which was not noticed by Fischer.

Athoracophorus, GOULD. (*Janella*, Gray; *Aneitea*, Gray; *Aneiteum*, McDon.; *Tribiniophorus*, Humbert.) Animal limaciform, subcylindrical, tapering behind: tentacles wanting: mantle anterior, small, triangular, lateral, adherent, enclosing one or more shell grains or plates: no longitudinal furrows above the margin of the foot, and no caudal mucus pore; no distinct locomotive disk: external respiratory and anal orifices on the right central margin of the mantle: orifice of combined genital system behind and below the right eye-peduncle.

Shell-plate internal, flat, calcareous, oblong, sometimes in separate grains.

Jaw smooth, with median projection and quadrate accessory plate.

Lingual membrane with peculiarly shaped teeth, with long, narrow, curving base of attachment, and low, transverse, multifid cusp.

New Hebrides, etc.

For figure of animal, shell-plate, jaw, and lingual dentition, see Fischer, Journ. de Conch., 1868, XVI. 230, Pl. XI.

The animal has peculiar dorsal grooves.

DOUBTFUL GENERA.

Parmella, H. & A. Adams. (Proc. Zoöl. Soc., 1867, 308, Pl. XIX. Fig. 20.) Fejee Islands. No information whatever given of the animal. Shell sigaretiform, as in *Gæotis*, *Peltella*, and *Mariella*.

Othelosoma, Gray. (Ann. Mag. Nat. Hist., New Series, III. 241.) Gaboon. No exact description given.

Damayantia, Issel. (Ann. Mus. Genov., VI., 1874, Pl. IV. Fig. 4–6 and woodcut.) No shell ; mantle anterior ; caudal pore. Borneo. I have not seen this description.

Aspidiporus, Fitz. (1833, Verz., 90.) Vienna. Like *Limax*, with perforated mantle.

Laconia, Gray. (Brit. Mus. Cat., 63.) Sublimaciform. Founded on Férussac's Fig. 10, 11, of Pl. VIII. F. Shell of *Vitrina*, with large caudal pore. Shell concealed by mantle : rather heliciform.

Oris, Risso. Syn. of *Onchidium ?*

Limacellus, Blainv. See Fér. Hist., p. 52, Pl. VII. Fig. 1, for full description and figure.

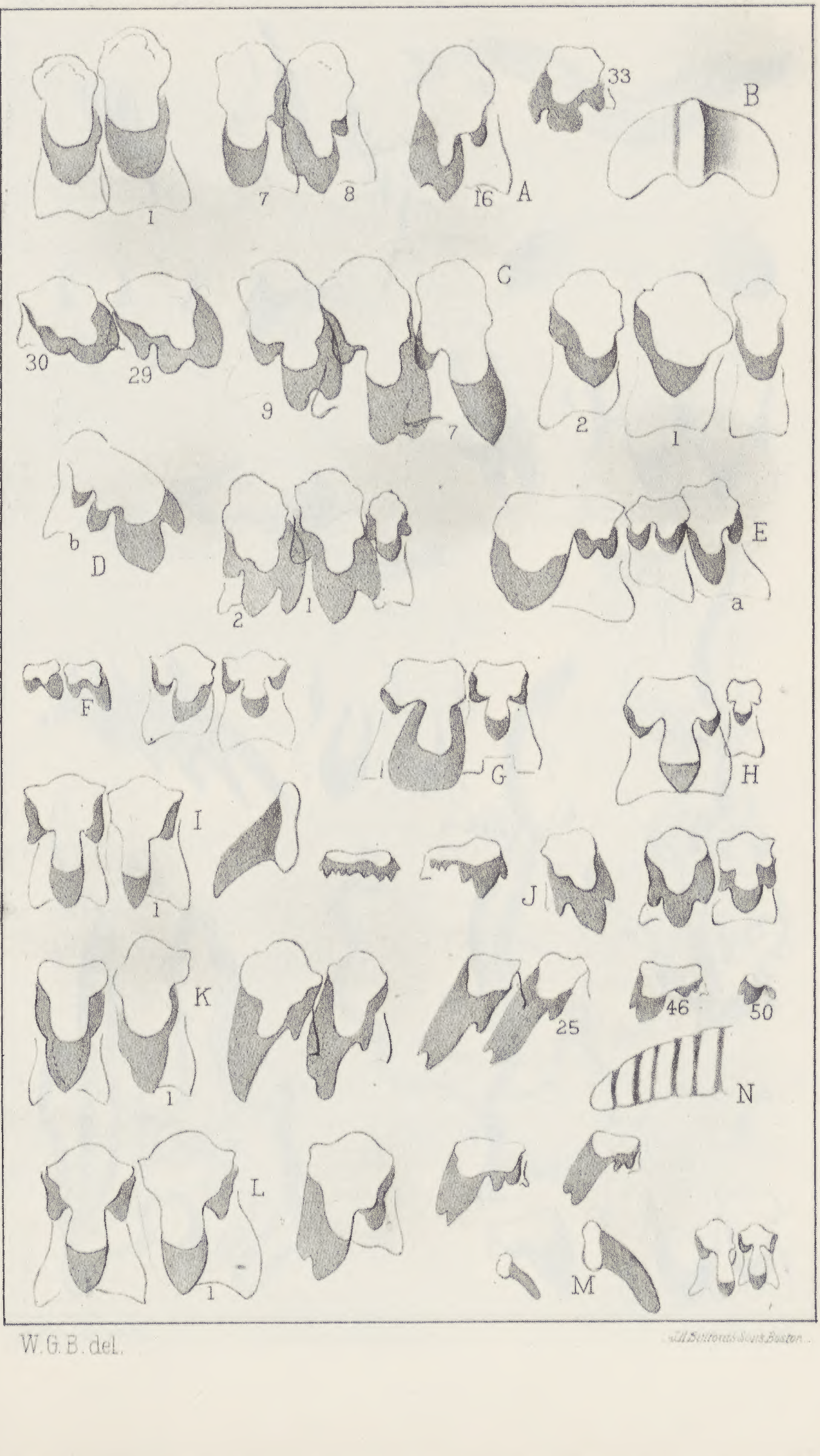
Parmula and **Scutelligera** are larvæ of insects. See Gray, Br. Mus. Cat., 161.

Eumelus, Deroceras, Zilotea, Urcinella, Testacina, Limacias, Rafinesque. (See Terr. Moll., V., and Binney and Tryon's edition of Rafinesque.)

Plectrophorus, Bosc. See Férussac, Hist., p. 84, Pl. VI. Fig. 5–7.

Phosphorax, Webb & Berth. Animal limaciform, swollen at middle : tentacles simple : mantle large, anterior, with a posterior, small, phosphorescent disk, and concealing a shell-plate : no longitudinal furrows above the margin of the foot, and no caudal mucus pore shown in plate: distinct locomotive disk ? external anal and respiratory orifices on right anterior margin of mantle: generative orifice ? Internal shell-plate thick, oval, testaceous. Jaw ? Lingual membrane ? Teneriffe. For figure of animal, see Férussac, Hist., Pl. II. Fig. 8. A doubtful genus, so little do we know of it. It is impossible to ascertain its systematic position.

A new genus of elasmognathous slug is indicated, but not named, in Zoöl. Rec., 1877, p. 74, founded on *Parmarion Kersteni*.



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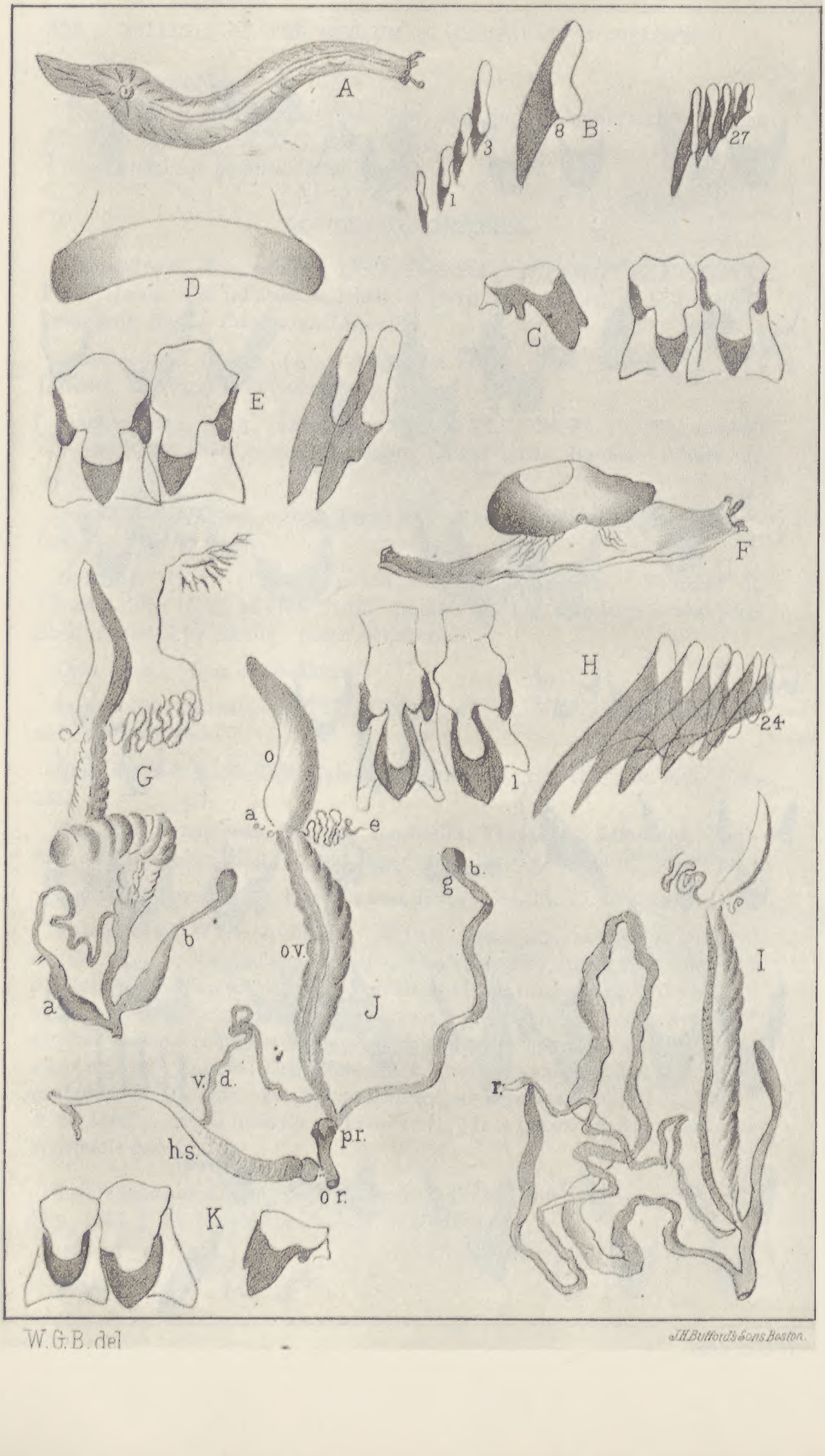

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BULLETIN

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MUSEUM OF COMPARATIVE ZOOLOGY

AT

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